CORRELATION BETWEEN INTERARM SYSTOLIC BLOOD PRESSURE DIFFERENCE AND CAROTID INTIMA MEDIA THICKNESS IN PATIENTS WITH CORONARY ARTERY DISEASE AND STROKE

DISSERTATION SUBMITTED FOR

M.D., BRANCH -V (PHYSIOLOGY)

MAY 2019

THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY,

CHENNAI, TAMILNADU.

MADURAI MEDICAL COLLEGE, MADURAI

BONAFIDE CERTIFICATE

This is to certify that the dissertation titled **"CORRELATION BETWEEN INTERARM SYSTOLIC BLOOD PRESSURE DIFFERENCE AND CAROTID INTIMA MEDIA THICKNESS IN PATIENTS WITH CORONARY ARTERY DISEASE AND STROKE''** is a bonafide record work done by **DR.M.MAHALAKSHMI,** under my direct supervision and guidance, submitted to The Tamilnadu Dr. M. G. R. Medical University in partial fulfillment of University regulation for **M.D., Branch-V (Physiology).**

Dr. P.S. L. Saravanan, M.D
Director (i/c) and Professor,
Institute of Physiology,
Madurai Medical College,
Madurai- 625020

CERTIFICATE FROM THE DEAN

This is to certify that the dissertation entitled **"CORRELATION BETWEEN INTERARM SYSTOLIC BLOOD PRESSURE DIFFERENCE AND CAROTID INTIMA MEDIA THICKNESS IN PATIENTS WITH CORONARY ARTERY DISEASE AND STROKE''** submitted by **Dr.M.MAHALAKSHMI** to the Faculty of Physiology, The Tamilnadu Dr.M.G.R. Medical University, Chennai in partial fulfilment of the requirement for the reward of M.D. Degree in Physiology is a bonafide work carried out by her during the period 2016-2019.

Place: Madurai
Date:

Prof.Dr.D. MARUTHUPANDIAN
M.S., F.I.C.S., F.A.I.S., FAC
Dean,
Madurai Medical College &
Govt. Rajaji Hospital, Madurai.

DECLARATION

I, **DR.M.MAHALAKSHMI** solemnly declare that the dissertation titled ‘‘**CORRELATION BETWEEN INTERARM SYSTOLIC BLOOD PRESSURE DIFFERENCE AND CAROTID INTIMA MEDIA THICKNESS IN PATIENTS WITH CORONARY ARTERY DISEASE AND STROKE’’** has been prepared by me. I also declare that this work was not submitted by me or any other, for any award, degree, diploma to any other University board either in India or abroad. This is submitted to The Tamilnadu Dr. M.G.R. Medical University, Chennai in partial fulfillment of the rules and regulation for the award of **M.D degree Branch-V (Physiology)** to be held in **May-2019.**

Place: Madurai **Dr. M.MAHALAKSHMI**

Date:

ACKNOWLEDGEMENT

I am deeply indebted to **Dr.P.S.L.Saravanan, M.D.,** The Director (i/c) and Professor, Institute of Physiology, Madurai Medical College, Madurai for the valuable guidance, inspiration, support and encouragement he rendered throughout this project.

My sincere thanks to **The Dean,** Madurai Medical College, Madurai for permitting me to undertake this study and I also thank **The Medical Superintendent,** Government Rajaji Hospital, Madurai for consenting to carry out the investigations in the hospital.

I express my profound gratitude to D**r.N.Ethiya, M.D., D.C.H., Dr.K.Muthuselvi, M.D., D.G.O** and **Dr.C.Anitha Mohan, M.D., D.C.H.,** Associate Professors, Institute of Physiology, Madurai Medical College, for their support and guidance for doing this study. I convey my gratefulness to **Dr. K.Vidhya, M.D.,** Assistant Professor, Institute of Physiology, Madurai Medical College, for her valuable guidance in this study.

I express my sincere thanks to The Professor and Head, Department of Medicine and Department of Radiology, Government Rajaji Hospital, Madurai for their valuable support to this project.

I express my profound thanks to all the Assistant Professors, Institute of Physiology, Madurai Medical College for their inspiring guidance.

My heartfelt gratitude goes to all my colleagues and all the staff members of this Institute of Physiology for their constant support and encouragement.

I gratefully acknowledge all the subjects who co-operated to submit themselves for this study.

INDEX

INTRODUCTION

INTRODUCTION

Cardiovascular diseases (CVDs) have now become the leading cause of mortality in India. A quarter of all mortality is attributable to cardiovascular diseases. Ischemic heart disease and stroke are the predominant causes and are responsible for >80% of cardiovascular disease deaths.

Recent reports of 3 large prospective studies from India suggest a higher proportion of mortality attributable to cardiovascular disease (30%–42%) and an age-standardized cardiovascular disease mortality rate (255–525 per 100000 populations in men and 225–299 per 100000 populations in women) in comparison with the Global Burden of Disease study. Thus cardiovascular disease has emerged as the leading cause of death in all parts of India, including poorer states and rural areas.

Countering the epidemic, requires the development of strategies such as the formulation and effective implementation of evidence based policy and reinforcement of health systems. Emphasis on prevention requires methods for early detection. Treatment requires the use of both conventional and innovative techniques.

There are many risk factors for cardiovascular disease and some can be controlled but not others. The risk factors that can be controlled (modifiable) are: High blood pressure; high blood cholesterol levels; smoking; diabetes; overweight or obesity; lack of physical activity; unhealthy diet and stress. The importance of controlling blood pressure was finally embraced in practice guidelines in the first “Report of the Joint National Committee (JNC) on

Detection, Evaluation, and Treatment of High Blood Pressure" in 1977. It is now recognized universally that hypertension increases atherosclerotic cardiovascular disease incidence; the risk burden is 2–3-fold. Hypertension predisposes to all clinical manifestations of coronary heart disease including myocardial infarction, angina pectoris, and sudden death. Hence early detection of hypertension by routine clinical measurement of blood pressure becomes essential in the prevention of cardiovascular diseases.

In the measurement of blood pressure, the difference in blood pressure between arms was first described in 1900.Since 2001–2002, it was hypothesized that **Interarm difference of blood pressure** was associated with peripheral arterial disease and then reported the first prospective association of interarm difference of blood pressure with increased mortality. Since then, numerous studies have been done demonstrating the association of interarm difference of blood pressure wih cardiovascular mortality.

Studies also show that increase in **Carotid intima media thickness (CIMT)** is associated with increase in the risk of stroke and may help refine risk prediction. Since 2000, 7 guidelines or consensus statements have recommended measuring carotid intima media thickness and/or carotid plaque detection as clinical tools to assist with cardiovascular disease risk prediction.

The Atherosclerosis Risk in Communities (ARIC) study measured carotid intima media thickness and observed that extreme mean carotid intima media thickness > 1 mm, when compared to mean carotid intima media thickness

< 1mm, was associated with an increased incidence of cardiovascular disease for both women and men.

In a new cross- sectional study of 1426 patients, Ma and colleagues have carefully examined the association of interarm systolic blood pressure difference (IASBPD) with carotid intima media thickness. They calculated maximum and average intima media thickness over 36 carotid sites, avoiding plaque, and achieved excellent interobserver agreement.

The prevalence of interarm systolic blood pressure varies from 1.9% to 19% as per systemic review and meta analysis of 16 studies. S.-J. Park et al. identifies interarm systolic blood pressure difference as a significant factor associated with the Gensini score, not only in hypertensive patients, but also in prehypertensive patients.

Hence a study is undertaken in our Institution to know the correlation between inter arm systolic blood pressure difference and carotid intima media thickness in patients with coronary artery disease and stroke. This cost effective technique of recording of interarm systolic blood pressure difference in hypertensive patients will help to identify individuals at greater risk of cardiovascular diseases at an early stage even at the level of primary health care system.

AIM

AND

OBJECTIVES

AIM AND OBJECTIVES

1. To record the interarm systolic blood pressure difference in hypertensive patients with coronary artery disease and stroke.
2. To measure carotid intima media thickness in above patients by Carotid Doppler ultrasound.
3. To find out the correlation between interarm systolic blood pressure difference and carotid intima media thickness in above group.
4. To recommend the recording of interarm systolic blood pressure difference in hypertensive patients as a routine for identification of patients at risk of cardiovascular diseases at an early stage.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

HISTORICAL ASPECTS

The modern **history of hypertension** begins with the understanding of the cardiovascular system based on the work of physician **William Harvey** (1578–1657).The concept of hypertensive disease as a generalized circulatory disease was taken up by **Sir Clifford Allbutt**. However hypertension as a medical entity really came into being in 1896 with the invention of the cuff-based **sphygmomanometer** by **Scipione Riva-Rocci** in 1896.The term **essential hypertension** was coined by **Eberhard Frank** in 1911 to describe elevated blood pressure for which no cause could be found.

Nikolai N. Anichkov (1885–1964) first demonstrated the role of cholesterol in the development of atherosclerosis. In 1856, **Rudolph Virchow** proposed that the **lesions of atherosclerosis result from injury to the artery wall**.

The inter-arm difference in blood pressure has received attention globally was discovered by **Osler** in 1915 who noted first. The term inter arm difference was secondly recognized more than 95 years ago and employed in the year 1920 by **Cyriax**.

B-mode ultrasound measurements of the carotid intima-media thickness (CIMT) have been first described in 1986 by **Pignoli et al.** in an in vitro study of common carotid arteries. In 1991, **Salonen and colleagues** showed for the first time the in vivo use of ultrasound imaging for the evaluation of atherosclerotic changes in the carotid arteries.

INTRODUCTION

HYPERTENSION

Hypertension affects millions of people. It is estimated that by 2025, 1.56 billion adults will be living with hypertension .The overall occurrence is similar between both men and women, but differs with age. Blood pressure values increase with age and is very common with the elderly. In adults less than 45 years, hypertension is more common in men and above 65 years it affects women more than men.

This disease is sometimes called the "silent killer." Because it is usually asymptomatic until the damaging effects of hypertension (such as stroke, myocardial infarction, renal dysfunction, visual problems, etc.) are observed. Hypertension is a major risk factor for atherosclerotic cardiovascular disease and an important contributor to coronary events, heart failure, stroke and end-stage kidney disease.

BLOOD PRESSURE

Lateral pressure exerted by column of blood on the walls of blood vessels while flowing through it.

SYSTOLIC PRESSURE

The maximal arterial pressure during systole is called systolic blood pressure and occurs during ventricular ejection. It is a function of cardiac output. Normal systolic pressure is 90-119 mmHg.

DIASTOLIC PRESSURE

The minimal arterial pressure during diastole is called diastolic blood pressure and occurs just before the onset of ventricular ejection. Normal diastolic pressure is 60-79 mmHg.

PULSE PRESSURE

The difference between the systolic and diastolic blood pressures is the Pulse pressure. It ranges between 40 and 50 mmHg. High pulse pressure is indicative of systolic hypertension and indirectly determines decrease in elasticity of blood vessels.

MEAN ARTERIAL PRESSURE

It is the average blood pressure throughout the cardiac cycle, which determines the pressure head.

Mean Arterial Pressure = Diastolic blood pressure + 1/ 3 Pulse pressure

Normal Mean arterial pressure is 93mm / Hg (range: 90-100mm / Hg). Regional blood flow through an organ depends on it.

DEFINITION OF HYPERTENSION (CURRENT GUIDELINES)

When the arterial pressure is ≥120/80 mmHg, a person is said to have "elevated" pressure or hypertension.

American Heart Association and the American College of Cardiology published new guidelines in November 2017 for defining and treating hypertension. Based upon large-scale clinical studies, the following definitions are now applied to adults: The current guidelines lower the threshold for Stage 1 hypertension by 10 mmHg compared to JNC 7 & 8, which is a significant reduction.

Blood Pressure Categories in Adults (Current Guidelines)			
Category	**SystolicBP (mmHg)**		**DiastolicBP (mmHg)**
Normal	< 120	And	< 80
Elevated	120 – 129	And	< 80
Hypertension			
Stage 1	130 – 139	Or	80 – 89
Stage 2	≥140	Or	≥ 90

RISKFACTORS FOR HYPERTENSION

NONMODIFIABLE RISK FACTORS	MODIFIABLE RISK FACTORS
1.Ethnicity	1.Overweight or obesity
2.Increased age (>35 years)	2.Smoking
3.Family history of hypertension	3.High intake of dietary sodium
	4.Excessive use of alcohol
	5.Sedentary lifestyle
	6.High level of stress
	7.Poorly controlled Diabetes

BASIC PRINCIPLES OF BLOOD PRESSURE REGULATION

The major function of BP is to provide the driving force that moves blood through the vascular system to supply the needs of the tissues. Consequently, BP regulation is a complex physiologic function that depends on integrated actions of multiple cardiovascular, renal, neural, endocrine, and local tissue control systems. Hypertension is usually considered to be a disorder of the average level at which BP is regulated during resting conditions. The multiple local, hormonal, neural, and renal systems regulate BP by their influence on cardiac pumping or vascular resistance because mean arterial pressure is a product of cardiac output and total peripheral resistance.

FEEDBACK CONTROL SYSTEMS FOR BLOOD PRESSURE

SHORT TERM REGULATION

Three important neural control systems begin to function powerfully within seconds

1. ARTERIAL BARORECEPTORS

(In the pressure range of 180 – 200 mm/Hg)

Arterial baroreceptor reflex is mediated by stretch-sensitive sensory nerve endings in the carotid sinuses and the aortic arch. The rate of firing of these baroreceptors increases with arterial pressure, and the net effect is a decrease in sympathetic outflow, resulting in decreases in arterial pressure and heart rate. This is a primary mechanism for rapid buffering of acute fluctuations of arterial

pressure that may occur during postural changes, behavioral or physiologic stress, and changes in blood volume. They detect changes in BP and send appropriate autonomic reflex signals back to the heart and blood vessels to return the BP towards normal.

Although the arterial baroreceptors clearly provide a powerful means for acute BP regulation, their role in long-term BP regulation is controversial. Some studies suggest that the baroreceptors reset within a few days to the level of BP to which they are exposed and are reset to higher BP in chronic hypertension. Other experimental studies, suggest that the baroreceptors do not completely reset and may contribute to chronic BP regulation. With prolonged increases in BP, the baroreceptor reflexes may contribute to reductions in renal sympathetic activity and promote sodium and water excretion, attenuating the increase in BP.

Thus, impairment of baroreceptor reflexes may cause increased liability of BP in hypertension and may fail to attenuate the increase in BP caused by other disturbances.

2. CHEMORECEPTORS

(In the pressure range of 40 – 80 mm/Hg)

They are located in the carotid and aortic bodies and respond to following changes in the blood

1. Oxygen lack

2. Carbon dioxide excess

3. Hydrogen ion excess.

They initiate autonomic feedback responses that influence BP.

3. CENTRAL NERVOUS SYSTEM (CNS) ISCHEMIC RESPONSE

It responds within a few seconds to ischemia of the vasomotor center in the medulla, especially when BP falls below about 50 mm Hg. The carbon dioxide and lactic acid accumulated due to ischemia stimulate the neurons of vasomotor centre.

Excitation of vasomotor centre causes strong sympathetic stimulation leading to vasoconstriction and immediate increase in blood pressure. Each of these nervous control mechanisms works rapidly and can have potent effects on BP. Also note, however, that the feedback gains of these systems decreases with time, as a disturbance of BP is maintained.

INTERMEDIATE REGULATION

Within a few minutes or hours after a BP disturbance, additional controls react, including

1) **CAPILLARY FLUID SHIFT MECHANISM**

A shift of fluid from the interstitial spaces into the blood in response to decreased BP or a shift of fluid out of the blood into the interstitial spaces in response to increased BP.

2**) STRESS RELAXATION AND REVERSE STRESS RELAXATION**

When BP is high in the vessels, the vessels become stretched and continued to stretch for minutes or hours. This causes relaxation of blood vessels by vascular tone adjustment. When BP is low in the vessels, there occurs tightening of vessels by vascular tone adjustment.

3) **RENIN ANGIOTENSIN ALDOSTERONE SYSTEM (RAAS)**

When there is fall in BP, this system is activated and suppressed when BP increases above normal. This system is explained in detail in long term regulation of BP.

LONG-TERM BLOOD PRESSURE REGULATION

1. RENAL–BODY FLUID FEEDBACK MECHANISM

Pressure natriuresis and diuresis.

Extracellular fluid volume is determined by the balance between intake and excretion of salt and water by the kidneys. During steady-state conditions, there must be balance between intake and output of salt and water. Pressure natriuresis and diuresis is a key mechanism for regulating salt and water balance. Under most conditions, this mechanism stabilizes BP and body fluid volumes.

When BP increases above the renal set point, because of increased total peripheral resistance or increased cardiac pumping, this also increases sodium and water excretion via pressure natriuresis and diuresis. Extracellular fluid

volume continues to decrease, reducing venous return and cardiac output until BP returns to normal and fluid balance is reestablished.

An important feature of pressure natriuresis is that hormonal and neural control systems can amplify or attenuate the basic effects of BP on sodium and water excretion. Another important feature is that it continues to operate until BP returns to nearly the original set point.

2. THE RENIN-ANGIOTENSIN-ALDOSTERONE SYSTEM (RAAS)

The renin-angiotensin-aldosterone system (RAAS) plays an important role in regulating blood volume and systemic vascular resistance, which together influence cardiac output and arterial pressure. As the name implies, there are three important components to this system: 1) renin, 2) angiotensin, and 3) aldosterone. Renin, which is released primarily by the kidneys, stimulates the formation of angiotensin in blood and tissues, which in turn stimulates the release of aldosterone from the adrenal cortex.Renin is a proteolytic enzyme that is released into the circulation by the kidneys. Its release is stimulated by:

- Sympathetic nerve activation (acting through β_1-adrenoceptors)
- Renal artery hypotension (caused by systemic hypotension or renal artery stenosis)
- Decreased sodium delivery to the distal tubules of the kidney.

Juxtaglomerular (JG) cells associated with the afferent arteriole are the primary site of renin storage and release. A reduction in afferent arteriole pressure causes the release of renin from the juxtaglomerular cells, whereas

increased pressure inhibits renin release. $Beta_1$-adrenoceptors located on the juxtaglomerular cells respond to sympathetic nerve stimulation by releasing renin. Specialized cells (**macula densa**) of distal tubules lie adjacent to the juxtaglomerular cells of the afferent arteriole. The macula densa senses the concentration of sodium and chloride ions in the tubular fluid.

When sodium chloride (Nacl) is elevated in the tubular fluid, renin release is inhibited. In contrast, a reduction in tubular sodium chloride stimulates renin release by the juxtaglomerular cells. When afferent arteriole pressure is reduced, glomerular filtration decreases, and this reduces sodium chloride in the distal tubule. This serves as an important mechanism contributing to the release of renin when there is afferent arteriole hypotension, which can be caused by systemic hypotension or narrowing (stenosis) of the renal artery that supplies blood flow to the kidney.

When renin is released into the blood, it acts upon a circulating substrate, **angiotensinogen**, that undergoes proteolytic cleavage to form the decapeptide **angiotensin I**. Vascular endothelium, particularly in the lungs, has an enzyme, **angiotensin converting enzyme (ACE)**, that cleaves off two amino acids to form the octapeptide, **angiotensin II** (AII), although many other tissues in the body (heart, brain, vascular) also can form angiotensin II.

Angiotensin II

Vasoconstrictor effect

It is a powerful vasoconstrictor. Angiotensin II–mediated constriction of efferent arterioles reduces renal blood flow and peritubular capillary hydrostatic

pressure and increases peritubular colloid osmotic pressure as a result of increased filtration fraction. These changes, in turn, increase the driving force for fluid reabsorption across tubular epithelial cells. Reductions in renal medullary blood flow caused by efferent arteriolar constriction or by direct effects of angiotensin II on the vasa recta may also enhance reabsorption in the loop of Henle and collecting ducts.

In most physiologic conditions, the constriction is confined mainly to the postglomerular efferent arterioles. The weak constrictor action of angiotensin II on preglomerular vessels is related, in part, to selective protection of these vessels by autacoid mechanisms such as prostaglandins (PGs) or endothelial-derived Nitric oxide.

Angiotensin II Stimulates Renal Sodium Reabsorption

Physiologic activation of the Renin-angiotensin-aldosterone system usually occurs as compensation for conditions that cause volume depletion or under perfusion of the kidneys, such as sodium depletion, hemorrhage or heart failure.

Increased angiotensin II formation helps restore renal perfusion by causing salt and water retention, which helps prevent reductions in blood pressure. It causes salt and water retention by increasing renal sodium reabsorption through stimulation of aldosterone secretion, by direct effects on epithelial transport and by hemodynamic effects.

Direct stimulation of tubular sodium reabsorption by angiotensin II occurs at low angiotensin II concentrations and is mediated in by actions on the luminal and basolateral membranes. In the proximal tubules, angiotensin II stimulates Na^+ H^+ exchanger on the luminal membrane and increases sodium-potassium ATPase activity as well as sodium bicarbonate cotransport on the basolateral membrane. These effects are partly mediated by inhibition of adenyl cyclase and increased phospholipase C activity.

Sodium reabsorption in the loop of Henle, macula densa, and distal nephron segments is also stimulated by angiotensin II. At physiologic concentrations, angiotensin II increases bicarbonate reabsorption in the loop of Henle and stimulates Na^+ K^+ $2Cl^-$ transport in the medullary thick ascending loop of Henle. Angiotensin II stimulates multiple ion transporters in the distal parts of the nephron as well as epithelial sodium channel activity in the cortical collecting ducts.

Other actions of angiotensin II

1. Acts on the adrenal cortex to release aldosterone, which in turn acts on the kidneys to increase sodium and fluid retention.
2. Stimulates the release of vasopressin (antidiuretic hormone, ADH) from the posterior pituitary, which increases fluid retention by the kidneys.
3. Stimulates thirst centers within the brain
4. Facilitates norepinephrine release from sympathetic nerve endings and inhibits norepinephrine re-uptake by nerve endings, thereby enhancing sympathetic adrenergic function.

5. Stimulates cardiac hypertrophy and vascular hypertrophy

ALDOSTERONE

The primary mineralocorticoid in humans is a powerful sodium-retaining hormone and has important effects on renal-pressure natriuresis and blood pressure regulation. The primary sites of actions of aldosterone on sodium reabsorption are the principal cells of the distal tubules, cortical collecting tubules, and collecting ducts where aldosterone stimulates sodium reabsorption and potassium secretion.

Aldosterone binds to intracellular mineralocorticoid receptors (MRs) and activates transcription by target genes, which in turn, stimulate synthesis or activation of the Na^+ K^+ ATPase pump on the basolateral epithelial membrane and activation of amiloride-sensitive sodium channels on the luminal side of the epithelial membrane. These effects are termed genomic because they are mediated by activation of gene transcription and require 60 to 90 minutes to occur after aldosterone administration.

Aldosterone may also exert rapid nongenomic effects on the cardiovascular and renal systems. Aldosterone increases the sodium current in principal cells of the cortical collecting tubule through activation of the amiloride-sensitive sodium channel and stimulates the Na^+-H^+ exchanger in a few minutes after application. In vascular smooth muscle cells, aldosterone stimulates sodium influx by activating Na^+-H^+ exchanger in less than 4 minutes. The renin-angiotensin-aldosterone pathway is not only regulated by the

mechanisms that stimulate renin release, but it is also modulated by natriuretic peptides released by the heart. These natriuretic peptides act as an important counter-regulatory system.

HUMORAL MECHANISMS

There are several very important humoral mechanisms including

1. Circulating catecholamines
2. Renin-angiotensin system
3. Vasopressin (antidiuretic hormone)
4. Atrial natriuretic peptide
5. Endothelin.

Each of these humoral systems directly or indirectly alter cardiac function, vascular function, and arterial pressure.

Circulating Catecholamines

Circulating catecholamines, epinephrine and norepinephrine, originate from two sources. Epinephrine is released by the adrenal medulla upon activation of preganglionic sympathetic nerves innervating this tissue. This activation occurs during times of stress (e.g., exercise, heart failure, hemorrhage, emotional stress or excitement, pain). Norepinephrine is also released by the adrenal medulla (about 20% of its total catecholamine release is norepinephrine). The primary source of circulating norepinephrine is spillover from sympathetic nerves innervating blood vessels.

Normally, most of the norepinephrine released by sympathetic nerves is taken back up by the nerves (some is also taken up by extra-neuronal tissues) where it is metabolized. A small amount of norepinephrine, however, diffuses into the blood and circulates throughout the body. At times of high sympathetic nerve activation, the amount of norepinephrine entering the blood increases dramatically. There is also a specific adrenal medullary disorder (chromaffin cell tumor) that causes very high circulating levels of catecholamine. This can lead to a hypertensive crisis.

Circulating epinephrine causes:

- Increased heart rate and inotropy (ß1-adrenoceptor mediated)
- Vasoconstriction in most systemic arteries and veins
- Vasodilation in muscle and liver vasculatures at low concentrations
- Vasoconstriction at high concentrations

The overall cardiovascular response to low-to-moderate circulating concentrations of epinephrine is increased cardiac output and a redistribution of the cardiac output to muscular and hepatic circulations with only a small change in mean arterial pressure. Although cardiac output is increased, arterial pressure does not change much because the systemic vascular resistance falls due to α 2-adrenoceptor activation. At high plasma concentrations, epinephrine increases arterial pressure because of binding to adrenoceptors on blood vessels, which offsets the α 2-adrenoceptor mediated vasodilation.

Circulating norepinephrine causes:

• Increased heart rate (although only transiently) and increased inotropy are the direct effects norepinephrine on the heart.

• Vasoconstriction occurs in most systemic arteries and veins

The overall cardiovascular response is increased cardiac output and systemic vascular resistance, which results in an elevation in arterial blood pressure. Heart rate, although initially stimulated by norepinephrine, decreases due to activation of baroreceptors and vagal mediated slowing of the heart rate.

Atrial Natriuretic Peptide

Atrial natriuretic peptide (ANP, ANF) is a 28 amino acid peptide that is synthesized, stored, and released by atrial myocytes in response to atrial distension, angiotensin II, endothelin, and sympathetic stimulation.

Therefore, elevated levels of atrial natriuretic peptide are found during hypervolemic states (elevated blood volume) and congestive heart failure. Atrial natriuretic peptide is involved in the long-term regulation of sodium and water balance, blood volume and arterial pressure. This hormone decreases aldosterone release by the adrenal cortex, increases glomerular filtration rate (GFR), produces natriuresis and diuresis (potassium sparing), and decreases renin release thereby decreasing angiotensin II. These actions contribute to reductions in blood volume and therefore central venous pressure (CVP), cardiac output, and arterial blood pressure. Chronic elevations of atrial natriuretic peptide appear to decrease arterial blood pressure primarily by decreasing systemic vascular resistance. The

mechanism of systemic vasodilation may involve atrial natriuretic peptide receptor-mediated elevations in vascular smooth muscle cyclicGMP as well as by attenuating sympathetic vascular tone. This latter mechanism may involve atrial natriuretic peptide acting upon sites within the central nervous system as well as through inhibition of norepinephrine release by sympathetic nerve terminals. Therefore, atrial natriuretic peptide is a counter-regulatory system for the renin angiotensin-aldosterone system.

TYPES OF HYPERTENSION

1. Primary hypertension or Essential hypertension

2. Secondary hypertension

ETIOLOGY AND PATHOGENESIS

Hypertension is a disorder of BP regulation that results from an increase in cardiac output or an increase in total peripheral vascular resistance

.**PRIMARY HYPERTENSION**

Approximately 90-95% of patients diagnosed with hypertension have primary hypertension. This form of high blood pressure tends to develop gradually over many years. Unlike secondary hypertension, there is no known cause of primary hypertension.

Factors Influencing the Development of Primary Hypertension:

1. Family history of hypertension
2. Overweight

3. Alcohol consumption
4. Excess Consumption of Sodium Chloride

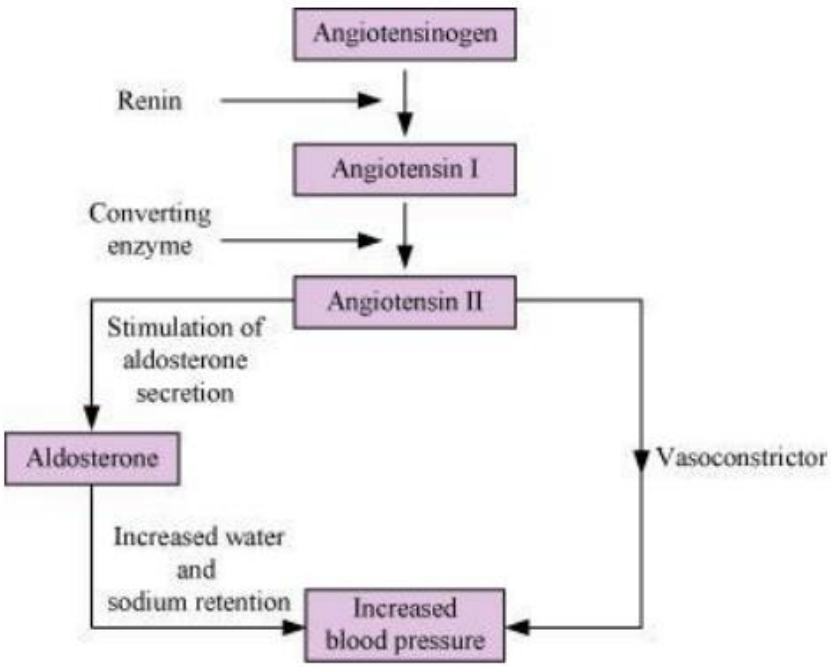
   Certain segments of the population are salt sensitive because their blood pressure is affected by salt consumption

5. Lack of Exercise activity

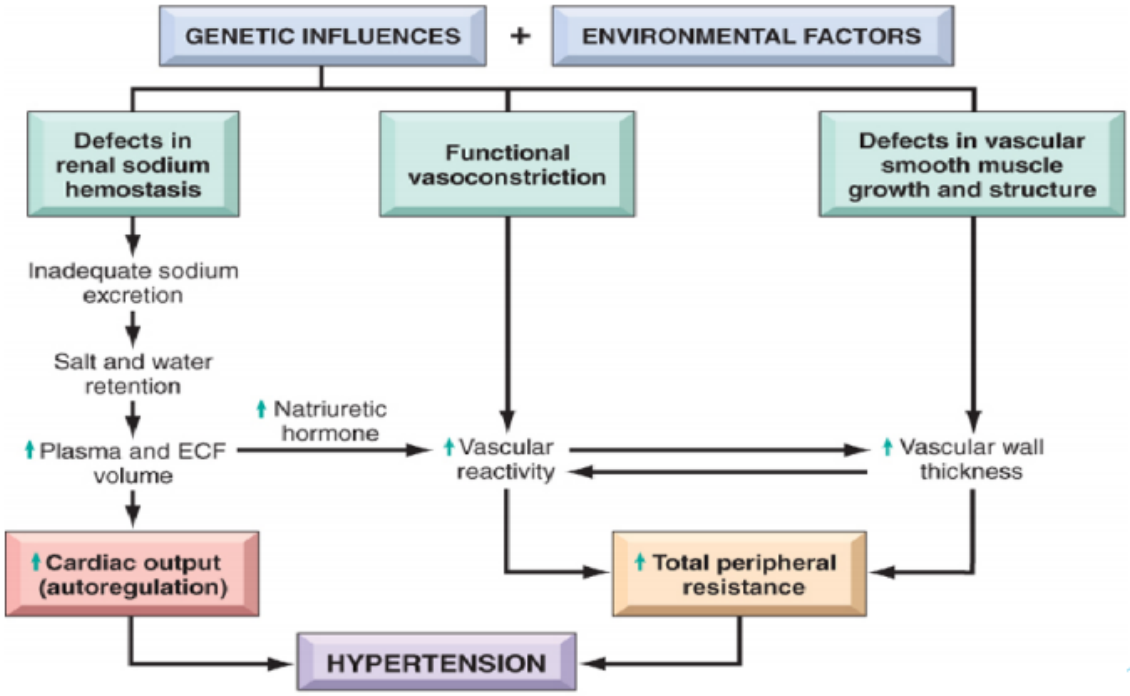
Less active individuals are 30-50% more likely to develop hypertension. Approximately 40–60% is explained by **genetic factors**. Important **environmental factors** include a high salt intake, heavy consumption of alcohol, obesity, lack of exercise and impaired intra uterine growth. There is little evidence that 'stress' causes hypertension.

MECHANISMS OF PRIMARY HYPERTENSION:

1. Increased activity of renin-angiotensin-aldosterone system



MECHANISMS OF PRIMARY HYPERTENSION



2- Hyperfunction of Sympathetic System

1. Primary increased activity of vasomotor neurons

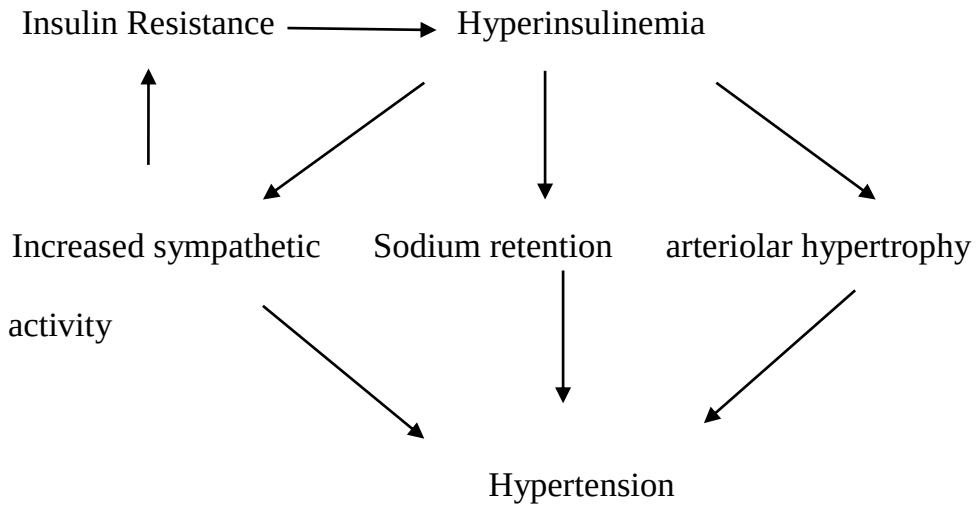
2. Angiotensin-II and endothelin increases activity of vasomotor neurons

3. Norepinephrine potentiates renin release.

3. Vasoactive substance: Endothelial dysfunction: Releasing of vasoactive agents like endothelin will increases blood pressure.

4. Renal defect to excrete sodium: Retention of sodium and water will lead to hypertension

5. Insulin Resistance



HEMODYNAMIC SUBTYPES OF PRIMARY HYPERTENSION

Primary hypertension falls into three distinctly different hemodynamic subtypes that vary sharply by age.

Systolic Hypertension in Teenagers and Young Adults

Typically associated with hypertension in the elderly, isolated systolic hypertension (ISH) also is the main type in young adults (typically 17 to 25 years of age). The key hemodynamic abnormalities are increased cardiac output and a stiff aorta, both presumably reflecting an overactive sympathetic nervous system.

The prevalence may reach as high as 25% in young men, but the condition affects only 2% of young women. Several recent studies show that young persons with isolated systolic hypertension have elevated central as well as brachial systolic blood pressures, indicating significantly increased hemodynamic burden. Thus isolated systolic hypertension in youth may predispose to diastolic hypertension in middle age.

Diastolic Hypertension in Middle Age

Hypertension diagnosed in middle age (typically 30 to 50 years of age) usually has the elevated diastolic pressure pattern, with normal systolic pressure (isolated diastolic hypertension) or elevated systolic pressure (combined systolic and diastolic hypertension). This pattern constitutes classic "essential hypertension." Isolated diastolic hypertension is more common in men and often associates with middle age weight gain.

Without treatment, isolated diastolic hypertension often progresses to combined systolic-diastolic hypertension. The fundamental hemodynamic fault is an elevated systemic vascular resistance coupled with an inappropriately normal cardiac output. Vasoconstriction at the level of the resistance arterioles

results from increased neurohormonal drive and an autoregulatory reaction of vascular smooth muscle to an expanded plasma volume, the latter because of impairment in the kidney's ability to excrete sodium.

Isolated Systolic Hypertension in Older Adults

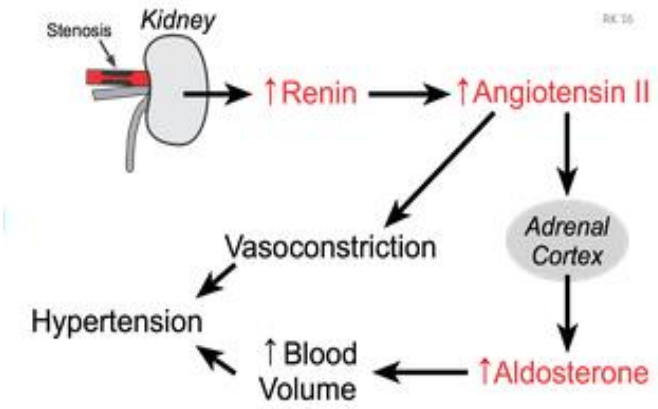
After the age of 55 years, Isolated systolic hypertension (systolic blood pressure >140 mm Hg and diastolic blood pressure < 90 mm Hg) predominates. In developed countries, systolic pressure rises steadily with age; by contrast, diastolic pressure rises until approximately 55 years of age and then falls progressively thereafter. The resultant widening of pulse pressure indicates stiffening of the central aorta and a more rapid return of reflected pulse waves from the periphery, augmenting systolic aortic pressure. Accumulation of collagen (which is poorly distensible) adversely affects its ratio to elastin in the aortic wall.

Isolated systolic hypertension may represent an exaggeration of this age-dependent stiffening process, although systolic blood pressure and pulse pressure do not rise with age in the absence of urbanization. Isolated systolic hypertension is more common in women and associates prominently with heart failure with preserved systolic function.

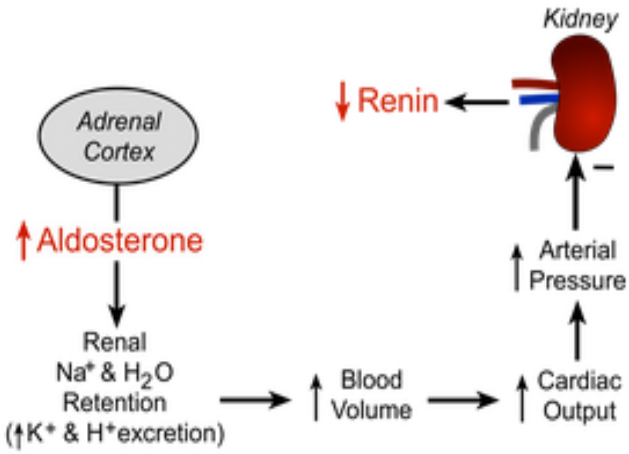
In an elderly patient with isolated systolic hypertension and stiff arteries, pulse wave velocity is 12 meters/sec, which is abnormally fast. The reflected pulse wave reaches the central aorta in systole, thereby amplifying central systolic pressure and widening the central pulse pressure. The augmented aortic

SECONDARY HYPERTENSION

Renal artery stenosis



Primary hyperaldosteronism



systolic pressure accelerates the development of Left ventricular hypertrophy, increases myocardial oxygen demand (MVO2), and accelerates endothelial dysfunction and atherosclerosis. The rapid diastolic runoff can compromise coronary perfusion pressure, thereby predisposing the patient to development of subendocardial ischemia.

SECONDARY HYPERTENSION

Secondary hypertension accounts for approximately 5-10% of all cases of hypertension. It has an identifiable cause. This form of high blood pressure tends to appear suddenly and often causes higher blood pressure than primary hypertension. Patient with secondary hypertension are best treated by controlling or removing the underlying disease or pathology although they may still require antihypertensive drugs.

Causes of secondary hypertension:

1. Renal artery stenosis
2. Chronic renal disease
3. Primary hyperaldosteronism
4. Stress and Sleep apnoea
5. Hyper or Hypothyroidism
6. Pheochromocytoma
7. Aortic coarctation

8. Preeclampsia

9. Drugs (oral contraceptives, NSAIDS, antidepressants, corticosteroids, sympathomimetics)

There are many known conditions that can cause secondary hypertension. Regardless of the cause, arterial pressure becomes elevated either due to an increase in cardiac output, an increase in systemic vascular resistance or both. When cardiac output is elevated. it is generally due to either increased neurohumoral activation of the heart or increased blood volume. Increased systemic vascular resistance is most commonly caused, at least initially, by increased sympathetic activation or by the effects of circulating vasoconstrictors (eg angiotensin11). Anatomic considerations such as narrowing of the aorta (eg coarctation) or chronic changes in vascular structure (eg vascular hypertrophy) can also cause or contribute to increased systemic vascular resistance.

MECHANISMS OF SECONDARY HYPERTENSION

1. Renal artery stenosis (Reno vascular disease)

Renal artery disease can cause narrowing of the vessel lumen (stenosis). The reduced lumen diameter decreases the pressure at the afferent arteriole and reduces renal perfusion. This stimulates renin release by the kidney, which increases circulating angiotensin II and aldosterone. These hormones increase blood volume by enhancing renal reabsorption of sodium and water.

Increased angiotensin-II also causes systemic vasoconstriction and enhances sympathetic activity. Chronic elevation of angiotension II promotes

cardiac and vascular hypertrophy. The net effect of these renal mechanisms is an increase in blood volume that augments cardiac output by Frank-Starling mechanism. Therefore hypertension caused by renal artery stenosis results from both increase in systemic vascular resistance and an increase in cardiac output.

2. Chronic renal disease

Any number of pathologic processes (eg diabetic nephropathy, glomerulonephritis) can damage nephrons in the kidney. When this occurs, the kidney cannot excrete normal amounts of sodium which leads to sodium and water retension, increased blood volume and increased cardiac output. Renal disease may also result in increased release of renin leading to renin dependent form of hypertension.

3. Primary hyperaldosteronism

Increased secretion of aldosterone generally results from adrenal adenoma or adrenal hyperplasia. Increased circulating aldosterone causes renal retention of sodium and water which causes blood volume and arterial pressure to increase. Plasma renin levels are generally decreased as the body attempts to suppress the renin- angiotensin system.

4. Stress

Emotional stress leads to activation of sympathetic nervous system, which causes increased release of norepinephrine from sympathetic nerves in the heart and blood vessels leading to an increased cardiac output and an increased systemic vascular resistance. Furthermore adrenal medulla secretes more

catecholamines. Activation of sympathetic nervous system increases circulating angiotensin II, aldosterone and vasopressin which can increase systemic vascular resistance.

Prolonged activation of angiotensin11 and catecholamines can lead to cardiac and vascular hypertrophy both of which can contribute to a sustained increase in blood pressure.

5. Sleep apnea

It is a disorder in which people repeatedly stop breathing for short periods of time (10 - 30 sec) during their sleep. These individuals have a high incidence of hypertension and the mechanism of hypertension may be due to sympathetic activation and hormonal changes associated with repeated periods of apnea induced hypoxia and hypercapnea and from stress associated with loss of sleep.

6. Hyperthyroidism and hypothyroidism

Both can lead to hypertension and the mechanisms of poorly understood. Elevated thyroxine levels cause increased blood volume through activation of renin-angiotensin-aldosterone system and increased heart rate and ventricular contractility. Recent studies suggest that cardiac changes are independent of sympathetic activity. Subnormal thyroxine levels reduce tissue metabolism, which may decrease the production of tissue vasodilator metabolites and endothelial production of nitric oxide and cause vasoconstriction and increased arterial pressure. There is also an increase in arterial stiffness.

7. Pheochromocytoma

Catecholomine secreting tumors of adrenal medulla can lead to very high levels of circulating catecholamines. This leads to alpha receptor mediated systemic vasoconstriction and beta receptor mediated cardiac stimulation both contribute to significant elevations in arterial pressure. The pheochromocytoma is diagnosed by measuring plasma or urine catecholomine levels and their metabolites (vanillylmandelic acid and metanephrine).

8. **Pre eclampsia**

This condition sometimes develops during second and third trimesters of pregnancy that causes hypertension due to increased blood volume and tachycardia.

9. Aortic coarctation

It is a congenital defect commonly found just distal to the left subclavian artery in the arch of aorta. This leads to reduced distal arterial pressure and elevated arterial pressure in the head and arms. The reduced arterial pressure activates renin-angiotensin-aldosterone system which leads to an increase in blood volume. This further increases pressure in upper body and may offset the reduction in lower body arterial pressure. This condition is diagnosed by greater arterial pressure in arms compared to arterial pressure in the legs. Because this is a chronic condition, baroreceptors are desensitized and upper body arterial pressure remains elevated because of increased cardiac output to these parts of body.

CONSEQUENCES OF HYPERTENSION

Hypertension is an independent predisposing factor for heart failure, coronary artery disease, stroke, renal disease, and peripheral arterial disease.

1. HEART

Heart disease is the most common cause of death in hypertensive patients. Hypertensive heart disease is the result of structural and functional adaptations leading to left ventricular hypertrophy, congestive heart failure, abnormalities of blood flow due to atherosclerotic coronary artery disease and micro vascular disease, and cardiac arrhythmias. Both genetic and hemodynamic factors contribute to left ventricular hypertrophy. Clinically, left ventricular hypertrophy can be diagnosed by electrocardiography, although echocardiography provides a more sensitive measure of left ventricular wall thickness. Individuals with left ventricular hypertrophy are at increased risk for coronary heart disease, stroke, congestive heart failure, and sudden death.

Congestive heart failure may be related to systolic dysfunction, diastolic dysfunction, or a combination of the two. Abnormalities of diastolic function that range from asymptomatic heart disease to overt heart failure are common in hypertensive patients. Approximately one-third of patients with congestive heart failure have normal systolic function but abnormal diastolic function

Diastolic dysfunction is an early consequence of hypertension-related heart disease and is exacerbated by left ventricular hypertrophy and ischemia. Cardiac catheterization provides the most accurate assessment of diastolic

function and it can be evaluated by several noninvasive methods, including echocardiography and radionucleotide angiography.

2. BRAIN

Stroke is the second most frequent cause of death in the world; it accounts for 5 million deaths each year, with an additional 15 million persons having nonfatal strokes. Elevated blood pressure is the strongest risk factor for stroke. Approximately 85% of strokes are due to infarction, and the remainders are due to either intracerebral or subarachnoid hemorrhage. The incidence of stroke rises progressively with increasing blood pressure levels, particularly systolic blood pressure in individuals > 65 years.

Hypertension is also associated with impaired cognition in an aging population. Hypertension-related cognitive impairment and dementia may be a consequence of a single infarct due to occlusion of a “strategic” larger vessel or multiple lacunar infarcts due to occlusive small vessel disease resulting in subcortical white matter ischemia. Cerebral blood flow remains unchanged over a wide range of arterial pressures (mean arterial pressure of 50–150 mmHg) through a process termed autoregulation of blood flow. In patients with the clinical syndrome of malignant hypertension, encephalopathy is related to failure of autoregulation of cerebral blood flow at the upper pressure limit, resulting in vasodilation and hyperperfusion. Untreated hypertensive encephalopathy may progress to stupor, coma, seizures, and death within hours.

3. KIDNEY

The kidney is both a target and a cause of hypertension. Primary renal disease is the most common etiology of secondary hypertension. Hypertension is a risk factor for renal injury and end-stage renal disease. Renal risk appears to be more closely related to systolic than to diastolic blood pressure for developing end stage renal disease at every level of blood pressure. Proteinuria is a reliable marker of the severity of chronic kidney disease and is a predictor of its progression.

Patients with high urine protein excretion (>3 g/24 h) have a more rapid rate of progression than do those with lower protein excretion rates. Atherosclerotic, hypertension-related vascular lesions in the kidney primarily affect preglomerular arterioles, resulting in ischemic changes in the glomeruli and postglomerular structures. Glomerular injury also may be a consequence of direct damage to the glomerular capillaries due to glomerular hyperperfusion.

With progressive renal injury there is a loss of autoregulation of renal blood flow and glomerular filtration rate, resulting in a lower blood pressure threshold for renal damage and a steeper slope between blood pressure and renal damage. The result may be a vicious cycle of renal damage and nephron loss leading to more severe hypertension, glomerular hyperfiltration, and further renal damage. Glomerular pathology progresses to glomerulosclerosis, and eventually the renal tubules may also become ischemic and gradually atrophic.

The renal lesion associated with malignant hypertension consists of fibrinoid necrosis of the afferent arterioles, sometimes extending into the glomerulus, and may result in focal necrosis of the glomerular tuft. Clinically, macroalbuminuria (a random urine albumin/creatinine ratio >300 mg/g) or microalbuminuria (a random urine albumin/creatinine ratio 30–300 mg/g) are early markers of renal injury. These are also risk factors for renal disease progression and cardiovascular disease.

4. VASCULAR COMPLICATIONS

In addition to contributing to the pathogenesis of hypertension, blood vessels may be a target organ for atherosclerotic disease secondary to long-standing elevated blood pressure. Hypertensive patients with arterial disease of the lower extremities are at increased risk for future cardiovascular disease. Although patients with stenotic lesions of the lower extremities may be asymptomatic, intermittent claudication is the classic symptom of Peripheral arterial disease (PAD). This is characterized by aching pain in the calves or buttocks while walking that is relieved by rest.

The ankle-brachial index is a useful approach for evaluating peripheral arterial disease and is defined as the ratio of noninvasively assessed ankle to brachial (arm) systolic blood pressure. An ankle-brachial index < 0.90 is considered diagnostic of peripheral arterial disease and is associated with > 50% stenosis in at least one major lower limb vessel. Several studies suggest that an ankle-brachial index < 0.80 is associated with elevated blood pressure, particularly systolic blood pressure.

Hypertensive patients have stiffer arteries, and arteriosclerotic patients may have particularly high systolic blood pressures and wide pulse pressures as a consequence of decreased vascular compliance due to structural changes in the vascular wall. Recent evidence suggests that arterial stiffness has independent predictive value for cardiovascular events. Clinically, a number of devices are available to evaluate arterial stiffness or compliance, including ultrasound and magnetic resonance imaging (MRI).

Vascular endothelial function also modulates vascular tone. The vascular endothelium synthesizes and releases a spectrum of vasoactive substances, including nitricoxide, a potent vasodilator. Endothelium-dependent vasodilation is impaired in hypertensive patients. This in turn leads to endothelial injury and atherosclerotic changes in the vessel wall. Endothelin is a vasoconstrictor peptide produced by the endothelium, and orally active endothelin antagonists may lower blood pressure in patients with resistant hypertension.

ATHEROSCLEROSIS

DEFINITION

Atherosclerosis is a thickening and hardening of large and medium-sized muscular arteries, primarily due to involvement of tunica intima and is characterised by fibrofatty plaques or atheromas. The term atherosclerosis is derived from athero-(meaning porridge) referring to the soft lipid-rich material in the centre of atheroma, and sclerosis (scarring) referring to connective tissue in the plaques.

Atherosclerosis is the commonest and the most important of the arterial diseases. Though any large and medium-sized artery may be involved in atherosclerosis, the most commonly affected are the aorta, the coronaries and the cerebral arterial systems.

Risk factors

Following risk factors which are associated with increased risk of developing clinical atherosclerosis. They are acting in combination rather than singly. These risk factors are divided into two groups.

RISK FACTORS FOR ATHEROSCLEROSIS

Major Risk factors	Emerging Risk factors
Modifiable	1.Environmental influences
1.Dyslipidaemia 2.Hypertension 3.Diabetes mellitus 4.Smoking	2.Obesity 3.Hormones: Oestrogen deficiency, Oral contraceptives 4.Physical inactivity
Constitutional	5.Stressful life
1.Age 2.Sex 3.Genetic factors 4.Familial and racial Factors	6.Homocystinuria 7.Alcohol 8.Prothrombotic factors 9.Infections(Herpes virus, Cytomegalo virus) 10.High C- Reactive Protein

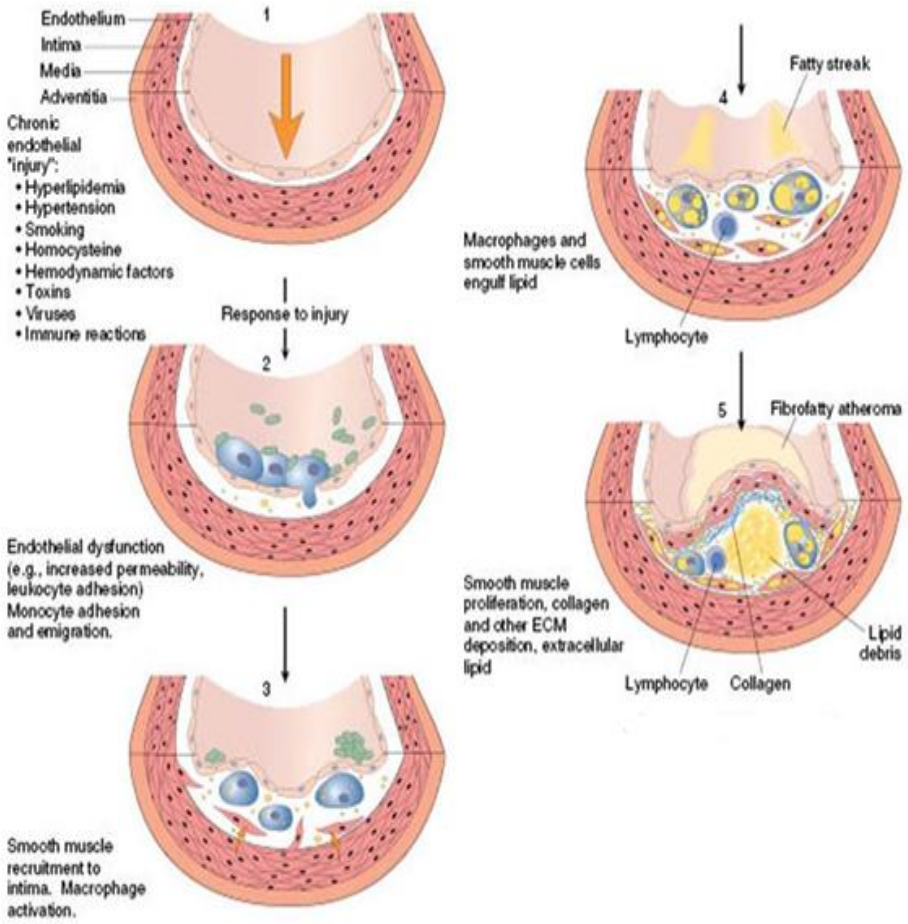
PATHOGENESIS

Atherosclerosis is a multi factorial process whose exact pathogenesis is still not known.

1. **Reaction-to-Injury Hypothesis**

This theory is most widely accepted and incorporates aspects of two older historical theories of atherosclerosis-the lipid theory of Virchow and thrombogenic theory of Rokitansky.

PATHOGENESIS OF ATHEROSCLEROSIS



The original response to injury theory was first described in 1973 according to which the initial event in atherogenesis was considered to be endothelial injury followed by smooth muscle cell proliferation so that the early lesions, according to this theory, consist of smooth muscle cells mainly. The modified response-to-injury hypothesis described subsequently in 1993 implicates lipoprotein entry into the intima as the initial event followed by lipid accumulation in the macrophages (foam cells) which according to modified theory, are believed to be the dominant cells in early lesions.

Role of key components involved in Atherogenesis

i) Endothelial injury

It has been known for many years that endothelial injury is the initial triggering event in the development of lesions of atherosclerosis. Endothelial dysfunction may initiate the sequence of events. Various causes of endothelial injury are: mechanical trauma, haemodynamic forces, immunological and chemical mechanisms, metabolic agent as chronic dyslipidaemia, homocysteine, circulating toxins from systemic infections, viruses, hypoxia, radiation, carbon monoxide and tobacco products.

In humans, two of the major risk factors which act together to produce endothelial injury are:

1. Haemodynamic stress from hypertension. The role of haemodynamic forces in causing endothelial injury is further supported by the distribution of

atheromatous plaques at points of bifurcation or branching of blood vessels which are under greatest shear stress.

2. Chronic dyslipidaemia

ii) **Intimal smooth muscle cell proliferation**

Endothelial injury causes adherence, aggregation and platelet release reaction at the site of exposed subendothelial connective tissue and infiltration by inflammatory cells. Proliferation of intimal smooth muscle cells and production of extracellular matrix are stimulated by various cytokines such as IL-1 and TNF-α released from invading monocyte-macrophages and by activated platelets at the site of endothelial injury. These cytokines lead to local synthesis of growth factors such as Platelet-derived growth factor (PDGF) and fibroblast growth factor (FGF).They stimulate proliferation and migration of smooth muscle cells from their usual location in the media into the intima.

Transforming growth factor-β (TGF-β) and interferon (IFN)-γ derived from activated T lymphocytes within lesions regulate the synthesis of collagen by smooth muscle cells. Smooth muscle cell proliferation is also facilitated by nitric oxide and endothelin released from endothelial cells.

iii) Role of blood monocytes

Though blood monocytes do not possess receptors for normal Low density lipoprotein (LDL), low density lipoprotein does appear in the monocyte cytoplasm to form foam cell. Plasma low density lipoprotein on entry into the intima undergoes oxidation. The ‘oxidised Low density lipoprotein’ formed in

the intima performs the following all-important functions on monocytes and endothelium:

a) **For monocytes**: Oxidised low density lipoprotein acts to attract, proliferate, immobilise and activate them as well as is readily taken up by scavenger receptor on the monocyte to transform it to a lipid laden foam cell.

b) **For endothelium**: Oxidised low density lipoprotein is cytotoxic. Death of foam cell by apoptosis releases lipid to form lipid core of plaque.

iv) Role of dyslipidaemia

Chronic dyslipidaemia in itself may initiate endothelial injury and dysfunction by causing increased permeability. In particular, hypercholesterolemia with increased serum concentration of low density liporotein promotes formation of foam cells, while high serum concentration of High density lipoprotein (HDL) has anti-atherogenic effect.

Thrombosis

As apparent from the foregoing, endothelial injury exposes subendothelial connective tissue resulting in formation of small platelet aggregates at the site and causing proliferation of smooth muscle cells. This causes mild inflammatory reaction which together with foam cells is incorporated into the atheromatous plaque. The lesions enlarge by attaching fibrin and cells from the blood so that thrombus becomes a part of atheromatous plaque.

The lesions of athrosclerosis begin with fatty streaks and gelatinous lesions. Full blown atheromatous lesions or fibrofatty plaques have a superficial cap and cellular or soft centre. Complicated atheromas may have dystrophic calcification, ulceration, thrombosis, haemorrhage and aneurysm formation.

Major clinical effects of atherosclerosis are on the

1. Heart -coronary artery disease

2. Brain- stroke

3. Aorta - aneurysmal dilatation

4. Intestine- ischaemia

5. Lower extremities- gangrene.

INTERARM BLOODPRESSURE DIFFERENCE

The inter-arm difference (IAD) in blood pressure has received attention globally was discovered by Osler in 1915 who noted first. The inter-arm blood pressure difference is an easily obtained and non-invasive parameter that clinical practitioners have investigated since the early 20th century. Hypertension guidelines recommend that blood pressure should be assessed in both arms at the initial visit, because differences exist and measurement in only one arm may lead to underdiagnosis of hypertension. These guidelines also suggest that arm with the higher values should be used for subsequent measurements.

When both arms are measured, it has been suggested that simultaneous measurement of both arms seems preferable since sequential measurement of BP overestimates the prevalence of systolic inter arm blood pressure difference. An average of at least three observations of blood pressure should be used to identify the interarm blood pressure difference in the left and right arm of patients diagnosed with severe diseases.

Arm blood pressure is generally higher on the right side than on the left, because the left subclavian artery originates from the aorta, thus making an acute angle, in contrast to the right artery. This acute angle leads to turbulent flow that reduces blood flow and blood pressure, therefore leading to an inter arm blood pressure difference.

Right and left arm pressure differences of a few mm of Hg are quite normal, but more than 10 mm of Hg could significantly increase the risk for cardiovascular outcomes, including increased cardiovascular mortality and all-cause mortality. In a recent meta-analysis of 20 studies, a systolic blood pressure difference of more than 15 mm Hg between the right and left arm was associated with a 2.5 greater risk of peripheral vascular disease, a 1.7 fold increase in cardiovascular mortality, and a 1.6 higher risk of all cause death . It has been suggested that inter-arm blood pressure difference may also be associated with an increased propensity for strokes.

CAUSES FOR INTERARM PRESSURE DIFFERENCE

Differences in blood pressure between arms may have a number of causes such as

1. Subclavian artery stenosis (due to atherosclerosis)

2. Aortic aneurysm and aortic coarctation

3. Vasculitis

4. Fibro muscular hyperplasia

5. Connective tissue disorders

6. Thoracic outlet compression.

Most common diagnostic entity would be subclinical atherosclerosis as suggested by the increased likelihood of finding an interarm difference in blood pressure and peripheral arterial disease.

Prevalence of Interarm systolic bloodpressure difference (IASBPD)

The reported prevalences of interarm blood pressure differences vary greatly; they are usually higher in the presence of hypertension. Meta analysis of recent studies on prevalences of a systolic interarm blood pressure difference ≥10 mmHg were 11.2% for seven populations with hypertension, 7.4% for six populations with diabetes and 3.6% for eight community based groups without diabetes or hypertension.The corresponding prevalences for interarm pressure differences ≥15 mmHg were 4.0% in hypertension 2.3% in diabetes and 0.7% without diabetes or hypertension (five cohorts). Gaynor et al in his study observed that 40.3% patients with stroke had an IASBPD >10mmHg.

IASBPD and Coronary artery disease

Kim et al. Medicine (2016) in his study observed, Coronary artery disease and cerebrovascular disease were more common in patients with significant systolic inter arm blood pressure difference. There was no significant difference in the prevalence of cardiovascular disease and cerebrovascular disease between patients with and without significant diastolic interarm pressure difference. The 10-year cardiovascular risk calculated by using the Framingham risk score was 9.3±7.7% in all patients, and male patients showed a higher risk of 12.9±7.5% (female patients: 5.2±5.5%). Results from multiple regression analysis show that the 10-year cardiovascular risk was weakly but significantly correlated with systolic interarm blood pressure difference.

S.-J. Park et al. in his study showed that interarm blood pressure difference, especially corrected- interarm blood pressure difference (BP-adjusted IABPD) is associated with the severity of coronary artery disease as indicated by the Gensini score. Thus, corrected- interarm blood pressure difference is an easily measured parameter that may be useful in clinical practice. A novel finding of their study is that corrected- interarm blood pressure difference had a linear correlation with the severity of coronary atherosclerosis (based on the Gensini score). Takanori Tokitsu et al in his study concluded that systolic interarm blood pressure differences were increased in coronary artery disease patients and correlated with its severity. Greater than 10 mmHg of inter arm difference of blood pressure was independently associated with future cardiovascular events. Assessing Interarm difference in blood pressure by Ankle Brachial Index measurement may facilitate risk stratification in coronary artery disease patients.

IASBPD and stroke

Clark et al 2012 in his systematic review and meta-analysis found, five cohorts (four non-invasive studies) reported a significant association between cerebrovascular disease and interarm blood pressure differences of 15 mm Hg or more. Pooled sensitivity was 8% and specificity 93%. Hirofumi Tomiyama et al in his article revealed that even mild inter arm difference in blood pressure, assessed by simultaneous measurement (≥ 5 mm Hg) is a predictor of Ankle Brachial Index < 0.90 in Japanese subjects with/without a past history of cardiovascular disease, and that inter arm blood pressure difference of ≥ 15 mm

Hg is a predictor of the future development of stroke in Japanese subjects without a past history of cardiovascular disease. These findings of the present study might emphasize the significance of the recommendation to measure blood pressure in both arms at the first visit.

Jinkwon Kim et al in his study concluded that the presence of interarm systolic or diastolic blood pressure difference >10 mm Hg is a strong independent prognostic marker in acute ischemic stroke.

IASBPD and peripheral arterial disease

Clark et al 2012 in his systematic review and meta-analysis observed, nine non-invasive studies showed that systolic interarm blood pressure difference of 15 mm Hg or more was linked with peripheral vascular disease in the leg, defined by direct measurement of ankle-brachial pressure index of less than 0·9 (five studies). In the Multi-Ethnic Study of Atherosclerosis, the presence of an inter arm systolic pressure difference of 15 mm Hg was associated with an increased risk of peripheral artery disease, an increased coronary calcium score and an increase in carotid intima-media thickness.

Jesper Mehlsen et al in their study observed that the mean numerical interarm difference in systolic blood pressure was higher in patients with definite peripheral artery disease compared to non- peripheral artery disease patients. In patients with definite peripheral artery disease, the numerical systolic blood pressure difference between arms exceeded 10 mmHg in 32.1%, 15 mmHg in

18.1%, 20 mmHg in 11.1%, and 25 mmHg in 6.7%. These values were significantly higher than in non- peripheral artery disease patients.

IASBPD and subclavian stenosis

From five case series of patients with angiographically proven asymptomatic subclavian stenosis (defined as >50% occlusion), for two studies the estimated mean blood pressure was 36·9 mm Hg lower in the arm with stenosis than in the other. The difference was similar in two other studies that could not be pooled (41 mm Hg and 21 mm Hg); one further study showed a mean intra-arterial pressure gradient of 28 mm Hg across stenoses of more than 75% in ten patients. Inter arm systolic blood pressure difference >10 mm/Hg has been shown to have a high sensitivity and a low specificity for angiographically significant subclavian artery stenosis.

IASBPD and Left ventricular hypertrophy

Lee W-H, et al. in his study observed that patients with an interarm systolic blood pressure difference ≥10 mmHg had higher prevalence of hypertension, higher mean arterial pressure, higher BMI, higher prevalence of ankle-brachial index 0.9, higher brachial ankle pulse wave velocity, higher Left Ventricular Mass Index and higher prevalence of concentric left ventricular hypertrophy.

Atherosclerosis directly caused a decrease in blood perfusion in the lower extremities and an increase in arterial wall stiffness, contributing to decreasing ankle-brachial index and arterial distensibility, and then final progressed to left

ventricular hypertrophy. Reversely, left ventricular hypertrophy caused a decrease in cardiac output, which further deteriorated deficiency of blood perfusion of the extremities and promoted the progression of peripheral arterial disease and increased interarm systolic blood pressure difference.

Arterial stiffness is associated with hypertrophy and atherosclerosis within the capacitance arteries that result in an increase in pulse wave velocity and consequent alterations in the pressure waveform and increases in systolic and pulse pressure. Alterations in wave reflections combined with increased stiffness may also contribute to left ventricular hypertrophy. Atherosclerosis and left ventricular hypertrophy may be possible mechanisms responsible for the association between an interarm systolic blood pressure difference of 10 mmHg or more and adverse cardiovascular outcomes.

Dellegrottaglie et al. evaluated the association between carotid-femoral pulse wave velocity and Left Ventricular Mass Index in chronic kidney disease and found a positive correlation between carotid-femoral pulse wave velocity and Left Ventricular Mass Index. Above mention studies revealed that detection of an interarm systolic blood pressure difference may provide a simple method of detecting patients at increased risk of atherosclerosis and cardiovascular complications.

CAROTID INTIMA MEDIA THICKNESS

. Carotid ultrasound has become a prominent focus of research and carotid intima–media thickness (CIMT) in particular has received attention as a safe, noninvasive and cost effective method to detect early atherosclerotic vascular diseases and cardiovascular disease risk.

In 1986, Pignoli et al. demonstrated that B-mode ultrasound was a useful method for the measurement of carotid intima–media thickness, where it appears as a 'double echo' in the artery wall. In 1991, Salonen and colleagues showed for the first time the in vivo use of ultrasound imaging for the evaluation of atherosclerotic changes in the carotid arteries. Since then, further studies have shown that the measurement of carotid intima–media thickness by B-mode ultrasound is reliable and reproducible.

In 2010, the American College of Cardiology Foundation (ACCF)/ American Heart Association (AHA) published their own guidelines for the assessment of cardiovascular risk in asymptomatic individuals. In the guideline, it is recommended that carotid intima–media thickness could be measured for the purposes of aiding cardiovascular risk classification in asymptomatic adults who are deemed to be at an intermediate risk.

Carotid intima–media thickness is defined as the distance between the lumen–intima interface and the media–adventitia interface. The process underlying intimal thickening is not fully understood but is thought to be due to underlying atherosclerosis. Atherosclerosis is a generalized process that affects

all arterial beds, including the carotid and coronary arteries. Thus atherosclerosis in the carotids should reflect coronary involvement, a fact that has been confirmed histologically by autopsy studies and concurrent atherosclerotic change visualized in the coronary arteries during angiography. Extracranial carotid arteries provide excellent and reproducible sites for intima- media thickness assessment because of accessibility, adequate size, and limited movement

Relations with established risk factors

There is a wealth of evidence on the relation between risk factors and increased carotid intima–media thickness which strengthen the notion that the measurement reflects atherosclerosis and increased cardiovascular risk. Traditional risk factors such as ageing, male gender, hypertension, increased body mass index, high low density lipoprotein (LDL) cholesterol, low high-density lipoprotein (HDL) cholesterol, diabetes and smoking have shown to be related to increased carotid intima–media thickness.

Of all traditional risk factors, hypertension appears to contribute most, probably through medial hypertrophy. The direction of the associations is generally similar in male and female. Subjects with a history of cardiovascular disease tend to have higher carotid intima–media thickness measurements as compared to those without a history of cardiovascular disease. Cumulative effects of cardiovascular risk factors on carotid intima–media thickness have been shown by the positive relationship with the Framingham risk score.

In addition to established risk factors, a number of new or emerging risk factors have been related with carotid intima–media thickness. For example, inflammation, as measured by C-Reactive Protein (CRP) is of critical importance in the pathogenesis of atherosclerosis. Elevated levels of C-reactive protein have been associated with increased carotid intima–media thickness. Finally, increased carotid intima–media thickness has been associated with atherosclerotic abnormalities in other organ systems, including the brain, heart, kidneys, lower limb arteries and brachial artery.

CIMT as a predictor of coronary artery disease and stroke

Early data from multiple large epidemiological studies showed that intima-media thickness is correlated with the extent of atherosclerosis in the coronary arteries. In the Kuopio Ischaemic Heart Disease Risk Factor Study, Intimal thickening of the carotid artery wall was found to be predictive of incident myocardial infarction (MI), with a 0.1-mm increase in intima-media thickening in representing an 11% increase in risk of myocardial infarction. In the Atherosclerosis Risk in Communities (ARIC) study, extreme mean carotid intima media thickness > 1 mm was associated with an increased incidence of cardiovascular disease for both women and men.

The Cardiovascular Health Study examined carotid intima media thickness in relation to future risk of myocardial infarction and stroke, subjects in the higher quintiles of maximal intima media thickness had an increased relative risk for myocardial infarction or stroke compared with those in the lower quintiles. In the Rotterdam Study, intima media thickness measured in the

common carotid artery, at the bifurcation and the combined measure were all significantly associated with incident myocardial infarction and stroke. In the Carotid Atherosclerosis Progression Study, intima media thickness measured in the common carotid artery and bifurcation remained predictive for myocardial infarction and stroke. In the Malmo Diet and Cancer Study, common carotid intima media thickness was associated with the incidence of stroke, independent of the presence of carotid plaque.

EUROPEAN SOCIETY OF CARDIOLOGY GUIDELINES (ESC) FOR MEASUREMENT OF CIMT

Examination of the carotid wall gives an opportunity to evaluate subclinical alterations in wall structure that precede and predict future cardiovascular clinical events. B-mode ultrasonography is a noninvasive, safe, easily performed, reproducible, sensitive, relatively inexpensive and widely available method for detection of early stages of atherosclerosis and is accepted as one of the best methods for evaluation of arterial wall structure.

Intima media thickness is defined as a double-line pattern visualised by echo 2D on both walls of the common carotid artery (CCA) in a longitudinal view. Two parallel lines (leading edges of two anatomical boundaries) form it: lumen-intima and media-adventitia interfaces.

CURRENT RECOMMENDATIONS FOR IMT MEASUREMENT

TYPE OF EQUIPMENT

- High-resolution B-mode system equipped with a linear array

transducer >7 MHz with minimal compression (<10:1) and

footprint of at least 3 cm

OBSERVATIONS RECOMMENDED

1. Inclusion of carotid bifurcation in the image plane serving as a landmark to provide accurate serial measurements
2. Intima media thickness measurement along a segment of the artery free of atherosclerotic plaque with clearly defined lumen-intima and media-adventitia interfaces
3. 10-mm-in-length straight arterial segment is required
4. Intima media thickness measured in triplicate
5. The far wall of the common carotid artery is preferred
6. Arterial wall segments assessed longitudinally and perpendicular to the ultrasound beam
7. Lateral probe position is preferred
8. Horizontal position of the artery in the image sector to optimise the visualization of lumen-intima interface
9. Intima media thickness measurement at a distance of at least 5 mm below the distal end of Common carotid artery (CCA) (Intima media thickness could also be measured at the carotid bifurcation and internal carotid artery bulb, but the values should be given separate)

MEASUREMENT GUIDELINES

1. Automatic or semi-automatic intima media thickness measurement, online or offline
2. Common carotid artery diameter (inter-adventitial and intraluminal) should also be measured (it correlates significantly with Intima media thickness)
3. Intima media thickness measured at end-diastole (R wave)

DATA TREATMENT

1. Intima media thickness values averaged
2. Mean Intima media thickness values are preferred (more reproducible than maximal values).Increased reproducibility of intima media thickness measurement when values from right and left common carotid artery are combined.

NORMAL VERSUS ABNORMAL VALUES

Normal intima media thickness values and reference ranges are age and sex dependent there is a significant steady increase in intima media thickness with advancing age in all carotid segment and significantly higher intima media thickness values in men than in women.

Normal value of carotid intima media thickness is difficult to obtain because the absolute values depends also on location of measurement (segment of artery, near or far wall), body habitus, ultrasound equipment used, imaging

depth, off line recording system (automated or manual tracking) and imaging quality obtained.

The American Society of Echography (ASE) Task force recommends that intima media thickness ≥75th percentile is considered high and indicative of increased cardiovascular risk. Values from the 25th to the 75^{th} percentile are considered average and indicative of unchanged cardiovascular risk. Values ≤ 25th percentile are considered low and indicate lower than the expected cardiovascular risk.

In the latest European Society of Cardiology hypertension guidelines (2013) carotid intima media thickness > 0.9 mm has been re-confirmed as a marker of asymptomatic organ damage, although it has been proven that in middle-aged and elderly patients the threshold values indicating high cardiovascular risk are higher.

V. Mohan et al.: (Intimal medial thickness in S. Indians) in his study evaluate normal intima-medial thickness of common carotid artery by B-mode ultrasound imaging and it was 0.74 ± 0.14 mm. Some studies also indicated that Carotid intima media thickness < 0.8 mm is associated with normal healthy individuals, and a value at or above 1 mm is associated with cardiovascular disease risk in any age group

Intima-media thickness is accepted as a marker of subclinical atherosclerosis and Intima-media thickness screening can help to reclassify a substantial proportion of intermediate cardiovascular risk patients into a lower or higher risk category.

MATERIALS AND METHODS

MATERIALS AND METHODS

PLACE OF STUDY

Study was conducted in the Department of Medicine and Department of Radiology, Government Rajaji Hospital in co-ordination with the Institute of Physiology, Madurai Medical College, Madurai for a period of eight months.

ETHICAL COMMITTEE

Approval obtained from the ethical committee of Government Rajaji Hospital, Madurai.

STUDY DESIGN

Cross sectional study

SAMPLE SIZE

Total subjects - 100

STUDY POPULATION

Both male and female hypertensive patients with coronary artery disease and stroke admitted in Medicine ward, GRH, Madurai.

INCLUSION CRITERIA:

1. Hypertensive patients with coronary artery disease and stroke.

2. Age: 45- 70 years.

3. Both male and female.

EXCLUSION CRITERIA:

1. Vasculitis

2. Connective tissue disorders

3. Aortic coarctation

4. Thoracic outlet syndrome

5. Atrial fibrillation

6. Traumatic and radiation injury to carotid artery.

7. Diabetes mellitus and chronic kidney disease.

8. Previous history of coronary artery disease/ stroke

MATERIALS USED FOR STUDY

1. Proforma – to record the anthropometric measurements and the clinical findings of the subjects.

2. Portable weighing machine – to record the body weight in kilograms.

3. Inch tape – to measure the standing height in centimeters.

4. Automated blood pressure measuring device (Omron HEM8712) -For recording interarm systolic blood pressure difference between both the arms.

5. Doppler USG Philips ultrasound machine – For measuring carotid intima media thickness.

METHODOLOGY:

The study was initiated after obtaining permission from Department of Medicine and Department of Radiology, Government Rajaji Hospital, Madurai.

Hypertensive patients diagnosed as coronary artery disease and stroke and admitted in the inpatient Department of Medicine were selected for the study. In the above cases diagnosis was confirmed by ECG, ECHO and CT Brain.

After getting informed written consent, detailed history was taken. General and Systemic examination was done. Blood samples were collected for baseline investigations.

The experimental protocol includes

1) RECORDING OF A DETAILED HISTORY

History of present illness

- Chest pain- Nature, any radiation, aggravated by exertion
- Difficulty in breathing
- Palpitations
- Giddiness
- Loss of consciousness
- Weakness of upper limb or lower limb
- Speech disturbance
- Drooling of saliva

- Deviation of angle of mouth
- Dysarthria
- Dysphagia
- Visual disturbance

History of past illness

- H/o similar episodes before
- H/o Transient ischemic attack
- H/o Hypertension
- H/o Diabetes mellitus and Chronic Kidney Disease
- H/o Peripheral vascular disease

2) MEASUREMENT OF ANTHROPOMETRIC INDICES:

The following were measured:

Weight (in kilograms) was recorded using a portable standard weighing machine.

Height (in centimeters) was measured to the nearest 0.5 cm using an inch tape.

Body Mass Index (BMI) was calculated using Quetelet's Index.

BMI = Weight (Kg)/ Height (m^2).

3) RECORDING OF VITAL SIGNS viz. pulse rate, respiratory rate, temperature were recorded and measurement of blood pressure was done as given below.

4) GENERAL EXAMINATION was done to elicit Pallor, Cyanosis, Icterus, Clubbing, Pedal edema, Lymphadenopathy.

5) EXAMINATION OF CARDIOVASCULAR SYSTEM was done.

6) EXAMINATION OF CENTRAL NERVOUS SYSTEM was done

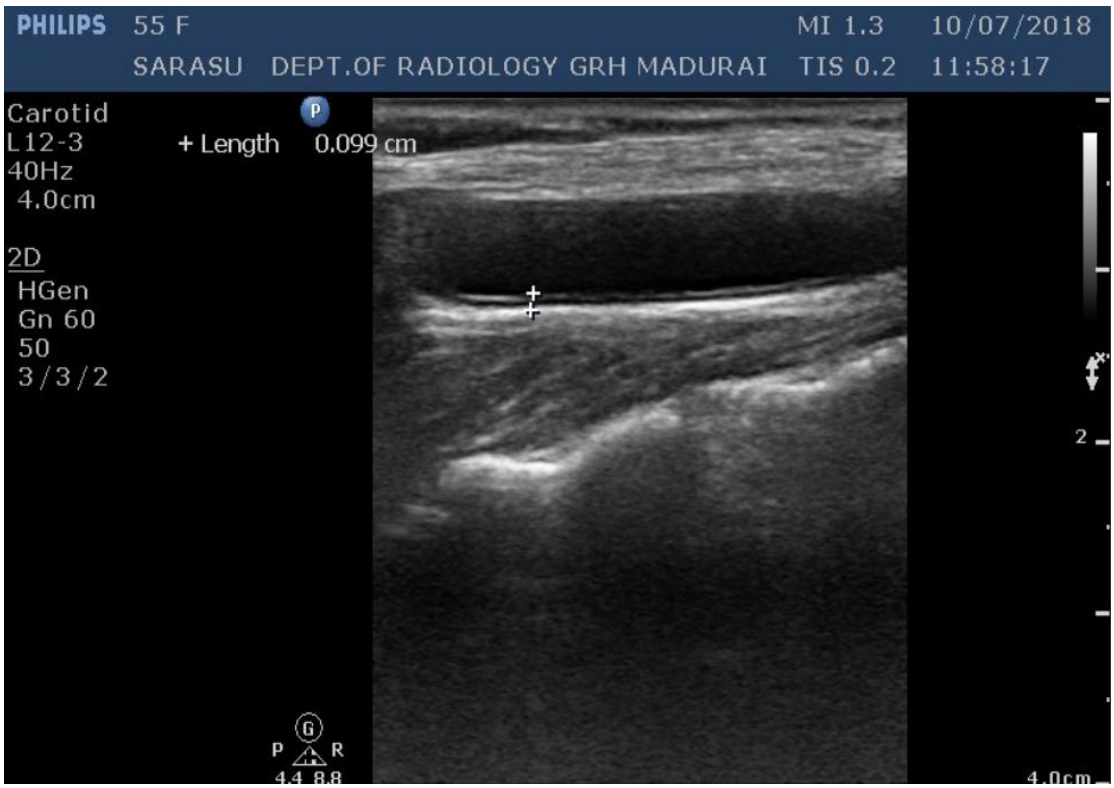
7) RECORDING OF INTERARM SYSTOLIC PRESSURE DIFFERENCE

BP measurements of both the arms were done using an automated blood pressure measuring device (Omron HEM-8712).Standard BP measurement techniques were followed and cuff size was tailored to the arm of an individual according to their mid-arm circumference.

BP was recorded simultaneously in both the arms following 5 minutes of rest with the patient in sitting position and with back support. The apparatus was kept at the level of heart during BP measurement**.** Recording of BP was repeated at 2 minutes interval for three times. The average of systolic BP for right arm was calculated and then the average of systolic BP for left arm was calculated. The average systolic BP of right arm was considered as systolic BP of right arm and average systolic BP of left arm was considered as systolic BP of left arm. The difference between right arm systolic BP and left arm systolic BP was calculated.

The interarm systolic BP difference was defined as the absolute difference of average systolic BP between the right arm and left arm. Absolute interarm systolic BP difference (IASBPD) was calculated by using the following formula.

CAROTID INTIMA MEDIA THICKNESS MEASUREMENT BY CAROTID DOPPLER ULTRASOUND



ABSOLUTE INTERARM SYSTOLIC BLOOD PRESSURE DIFFERENCE =

│Average Right arm systolic BP ─ Average Left arm systolic BP│

A large inter-arm systolic BP difference was defined as an absolute interarm systolic BP difference of greater than or equal to 10 mmHg**.**

8**) MEASUREMENT OF CAROTID INTIMA MEDIA THICKNESS**

In the Department of Radiology, Madurai Medical College. Doppler USG Philips ultrasound machine with 7- 14MHz frequency linear probe was used for measuring the carotid intima media thickness.

The examination was carried out by the sonologist with each subject lying supine, neck slightly extended and turned contra laterally to the carotid artery being examined; continuous scans were done in the longitudinal and transverse planes after the application of ultrasound gel. All measurements of the intima-media thickness was made in the longitudinal plane at the point of maximum thickness of the far wall of the common carotid artery (CCA) along a 1 cm section of the artery proximal to the carotid bulb. The position of the carotid bulb was defined as the point where the far wall deviated from the parallel plane of the distal common carotid artery.

The carotid intima media thickness was defined as the distance between the inner echogenic line representing the intima-blood interface and the outer echogenic line representing the adventitia-media junction. After freezing the image, the measurement was made with electronic calipers. Measurements were

repeated for 3 times, unfreezing the image of each occasion and relocating the position of maximal intima-media thickness. The maximal thickness of the intima-media width at both right and left distal common carotid artery was measured to give a total of six readings. The mean value of each set of readings represented the mean intima-media thickness of each side. Mean carotid intima media thickness value of right side was considered as right side carotid intima media thickness value and mean left side carotid intima media thickness value was considered as left side carotid intima media thickness value. Mean value of right and left side carotid intima media thickness was calculated.

Normal intima-medial thickness of common carotid artery by B-mode ultrasound imaging in Indians was 0.74 ± 0.14 mm and carotid intima media thickness < 0.8 mm was associated with normal healthy individuals. Carotid intima media thickness value at or above 0.8mm was considered abnormal. Carotid intima media thickness values at or above 1 mm was associated with cardiovascular disease risk in any age group.

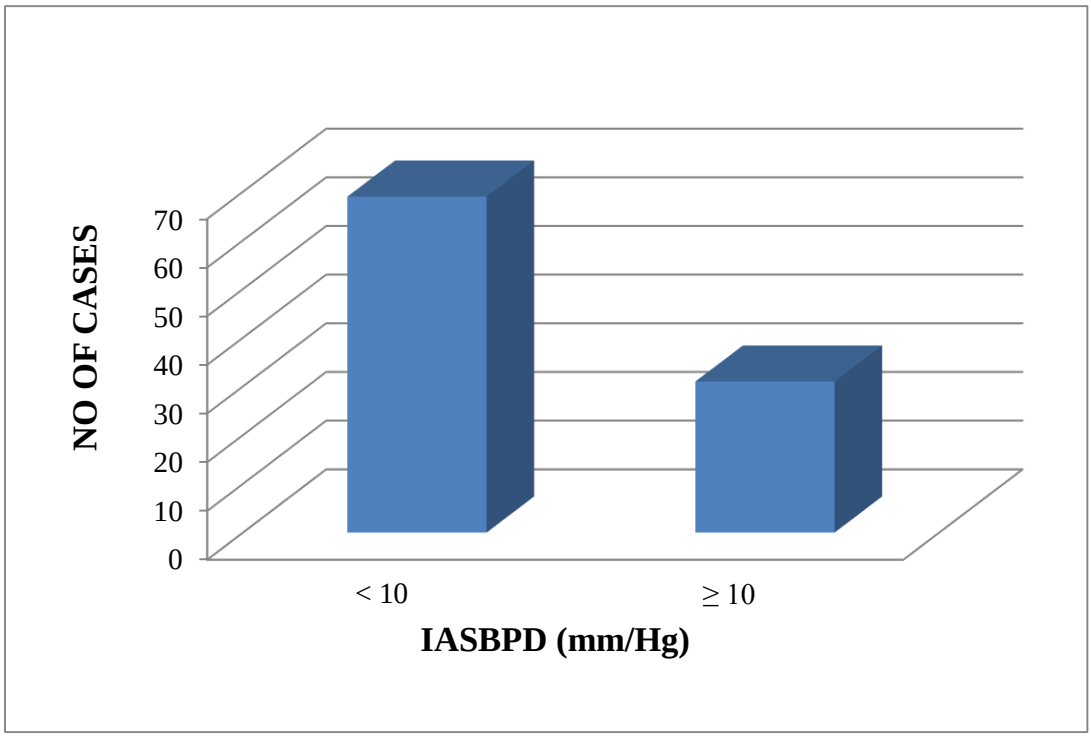
OBSERVATIONS AND RESULTS

RESULTS AND OBSERVATION

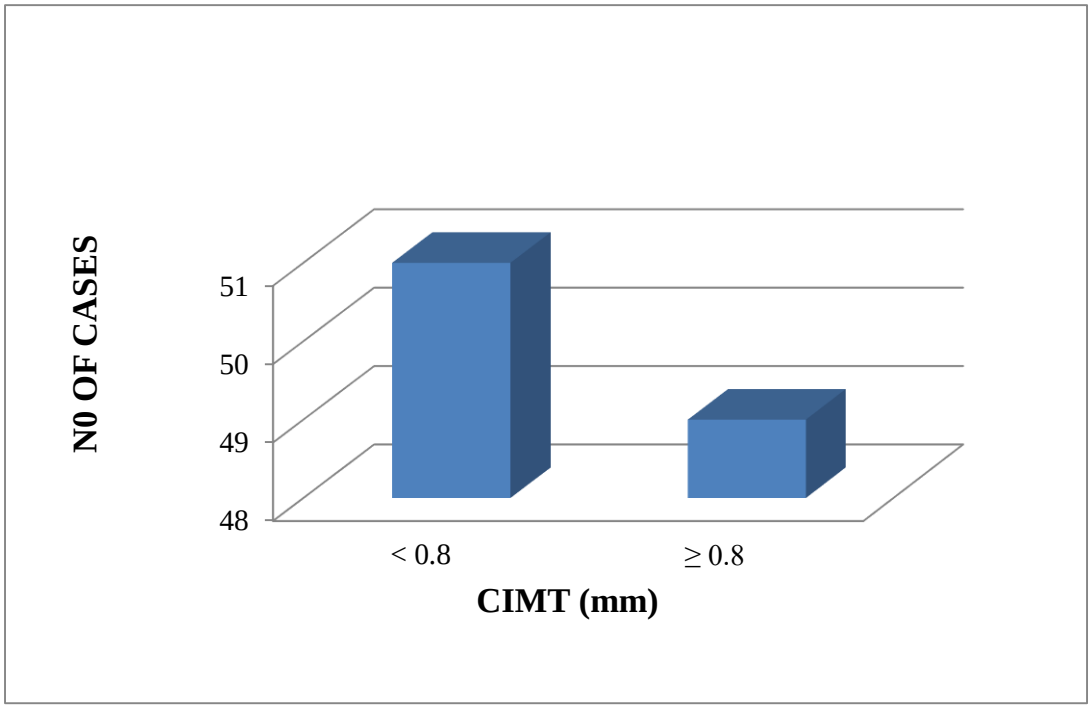
The correlation between Interarm systolic blood pressure difference (IASBPD) and carotid intima media thickness (CIMT) was analysed by using **Pearson's correlation coefficient test.**

Interarm systolic blood pressure difference and Carotid intima media thickness were also correlated with other variables such as age,BMI and total cholesterol. All these correlations were done using the same Pearson's correlation coefficient test. Gender association with IASBPD and CIMT was analysed by chi-square test. By means of **SPSS (Statistical Package for Social Sciences) software version 21,** analysis of statistics was performed**.** The **statistical significance** was drawn at **'p' value < 0.05.**

1. INTERARM SYSTOLIC BLOOD PRESSURE DIFFERENCE (IASBPD)



2. CAROTID INTIMA MEDIA THICKNESS (CIMT)



1.INTERARM SYSTOLIC BLOODPRESSURE DIFFERENCE

IASBPD (mm/Hg)	No of cases
< 10	69
≥ 10	31
Total	100
MEAN± SD	7.2 ± 4.62

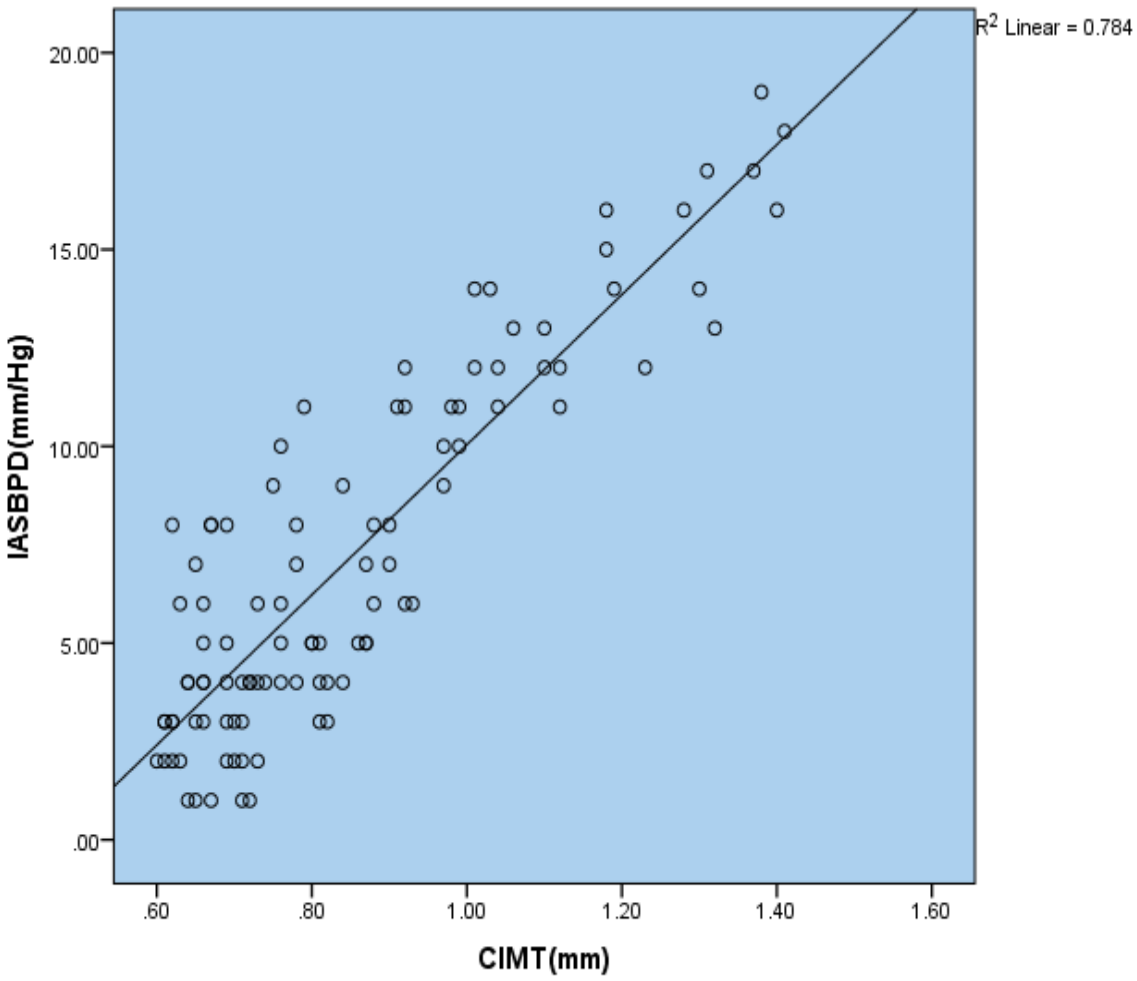
Table – 1 showing IASBPD of study population. Mean IASBPD was 7.2 ± 4.62 mm/Hg. IASBPD ≥ 10mm/Hg was present in 31 cases.

2. CAROTID INTIMA MEDIA THICKNESS

CIMT in mm	No of cases
< 0.8	51
≥ 0.8	49
Total	100
MEAN ± SD	0.85 ± 0.21

Table – 2 showing CIMT of study population. Mean CIMT was 0.85±0.2 mm. CIMT ≥ 0.8mm was present in 49 cases.

3. CORRELATION BETWEEN IASBPD AND CIMT

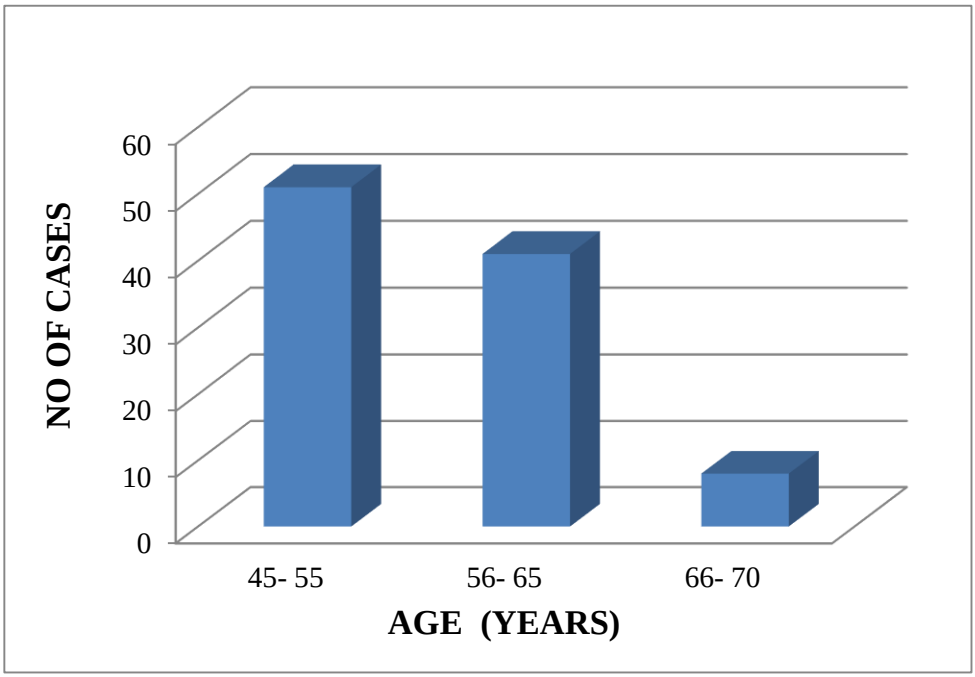


3. CORRELATION BETWEEN IASBPD AND CIMT

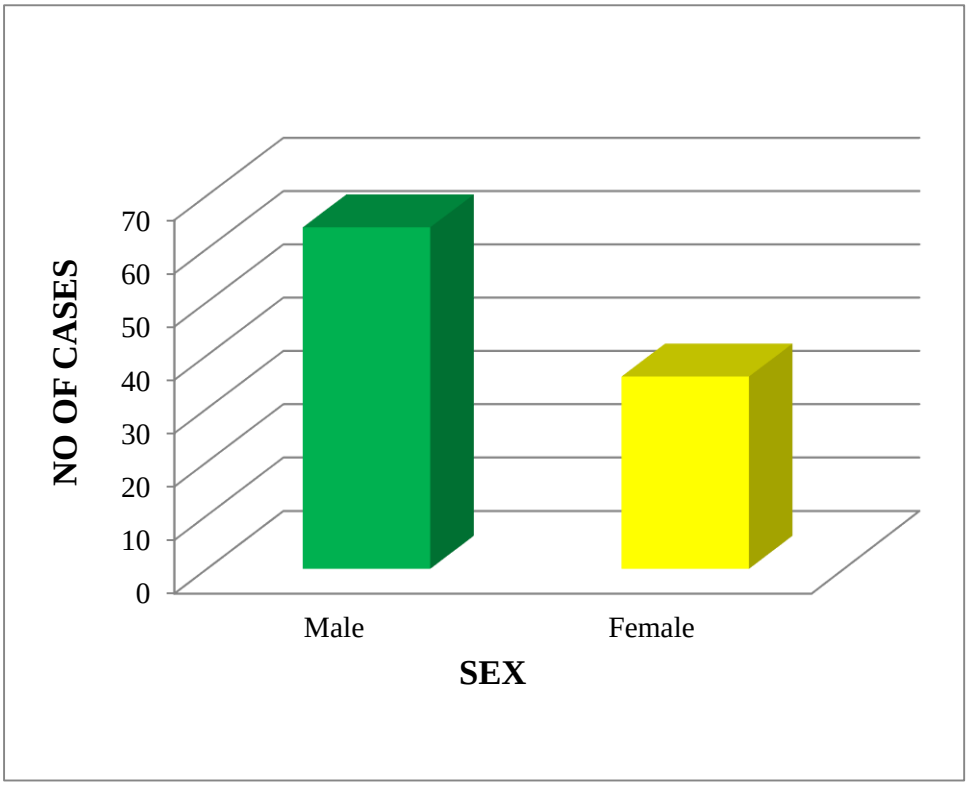
Variable	**IASBPD in mm/Hg**	
	r value	**p value**
CIMT in mm	0.885	0.00001 **Significant**

Table – 3 showing correlation between IASBPD and CIMT of study population. Analysis was done using Pearson's correlation coefficient test. There was a statistically significant positive correlation between IASBPD and CIMT.

4. AGE DISTRIBUTION



5. SEX DISTRIBUTION



4. AGE DISTRIBUTION

Age (years)	No of cases
45- 55	51
56- 65	41
66- 70	8
Total	100
MEAN± SD	56.16 ± 6.00

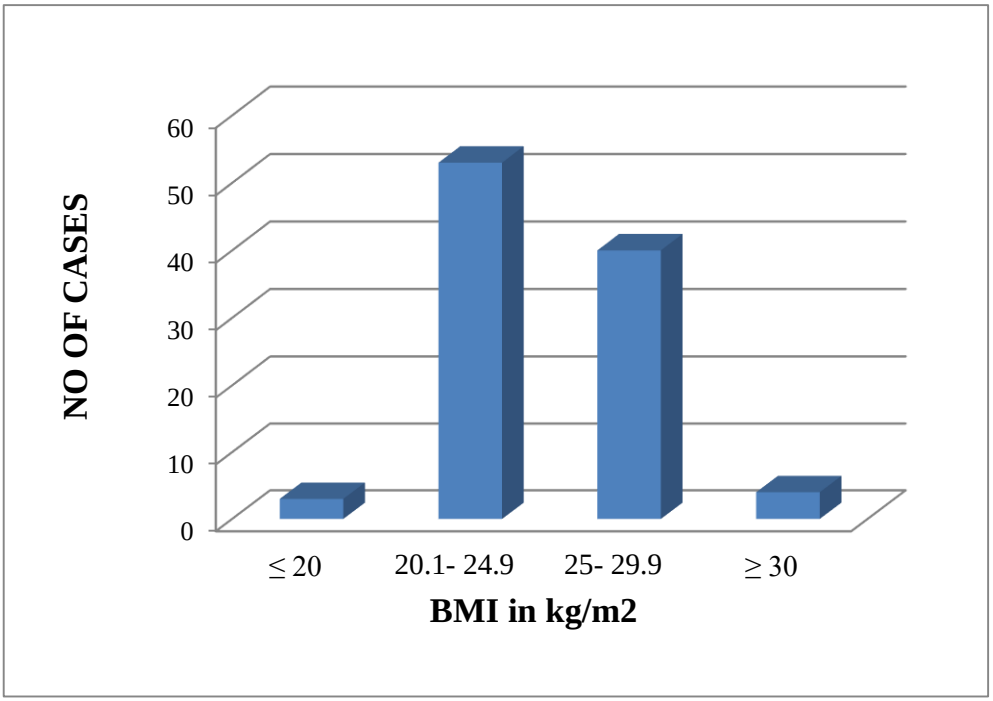
Table - 4 showing age distribution of study population. Mean age was 56.16 ± 6.00 years.

5. SEX DISTRIBUTION

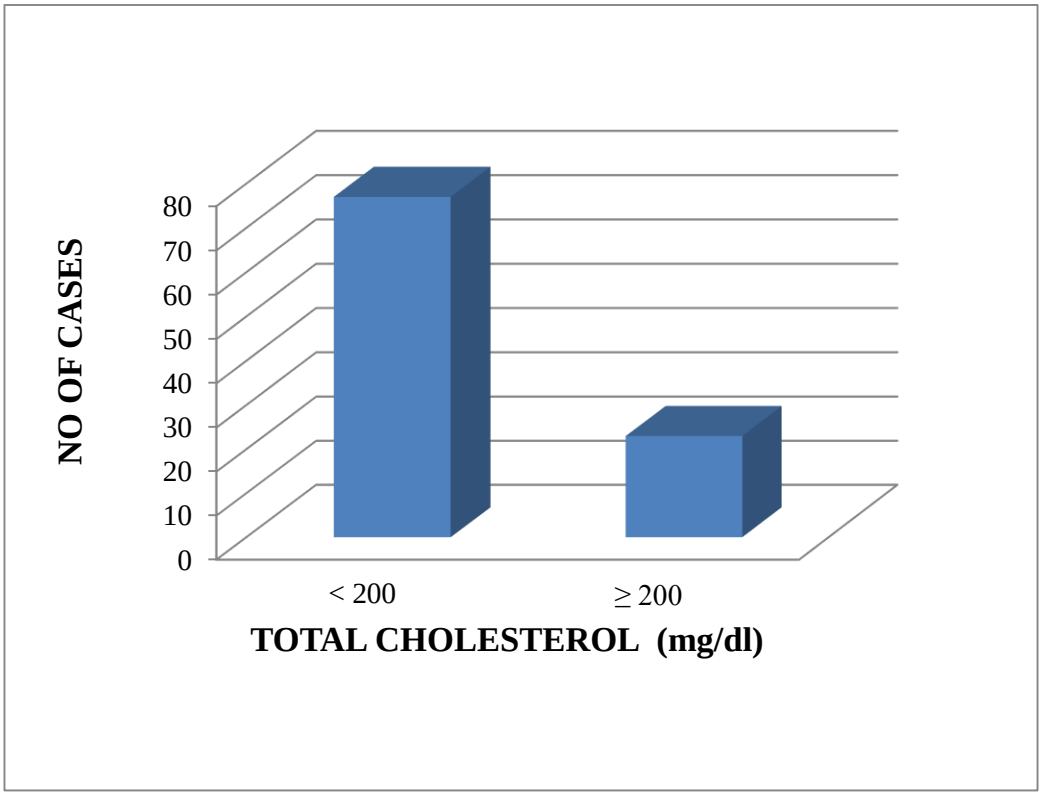
SEX	No of cases
Male	64
Female	36
Total	100

Table – 5 showing sex distribution of study population.

6. BODY MASS INDEX DISTRIBUTION



7. TOTAL CHOLESTEROL



6. BODY MASS INDEX

BMI(kg/m^2)	No of cases
≤ 20	3
20.1- 24.9	53
25- 29.9	40
≥ 30	4
Total	100
MEAN± SD	24.61 ± 2.43

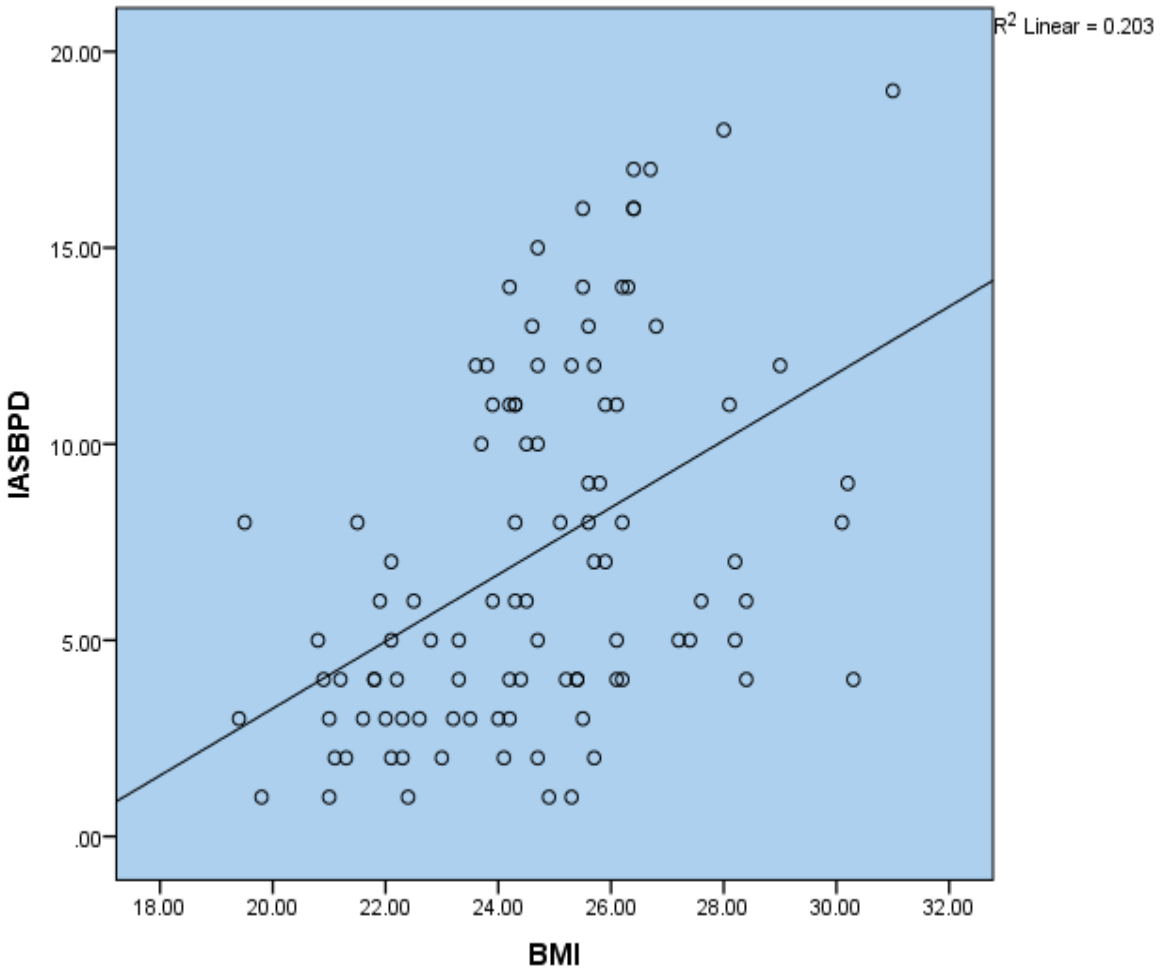
Table – 6 showing BMI of study population. Mean BMI was 24.61 ± 2.43 kg/m^2.

7. TOTAL CHOLESTEROL

Total cholesterol (mg/dl)	No of cases
< 200	77
≥ 200	23
Total	100
MEAN± SD	186 ± 15.748

Table – 7 showing total cholesterol of study population. Mean cholesterol was 186 ± 15.748 mg/dl. Total cholesterol ≥ 200 mg/dl was present in 23 cases.

8. CORRELATION BETWEEN IASBPD AND BMI

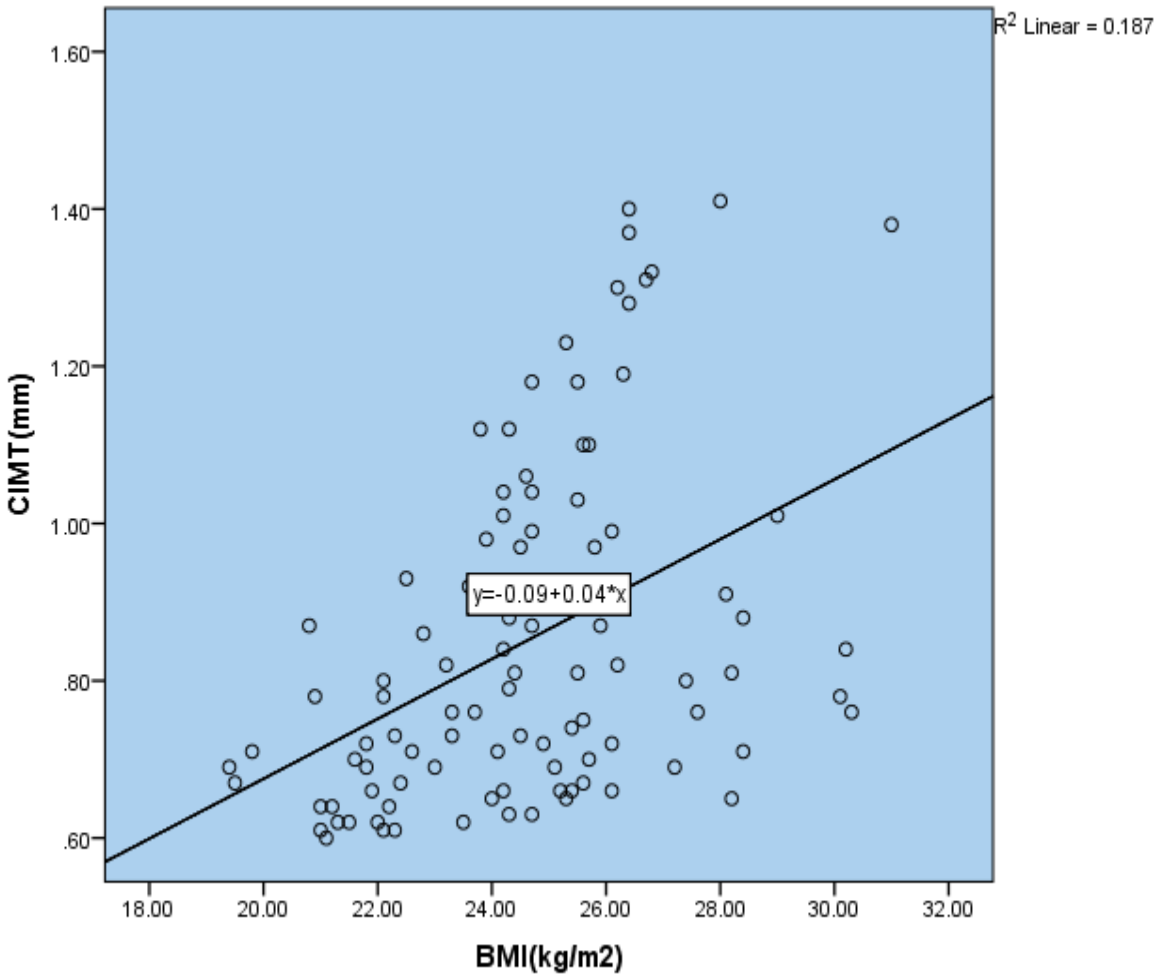


8. CORRELATION OF IASBPD WITH AGE, BMI AND CHOLESTEROL

Variable	**IASBPD in mm/Hg**	
	r value	**p value**
AGE (years)	0.464	0.00001 **significant**
BMI(kg/m^2)	0.450	0.00001 **significant**
TOTAL CHOLESTEROL (mg/dl)	0.606	0.00001 **significant**

Table – 8 showing correlation of IASBPD with age, BMI and cholesterol of study population. Analysis was done using Pearson's correlation coefficient test. There was a statistically significant positive correlation of IASBPD with age, BMI and total cholesterol.

9.CORRELATION BETWEEN CIMT AND BMI

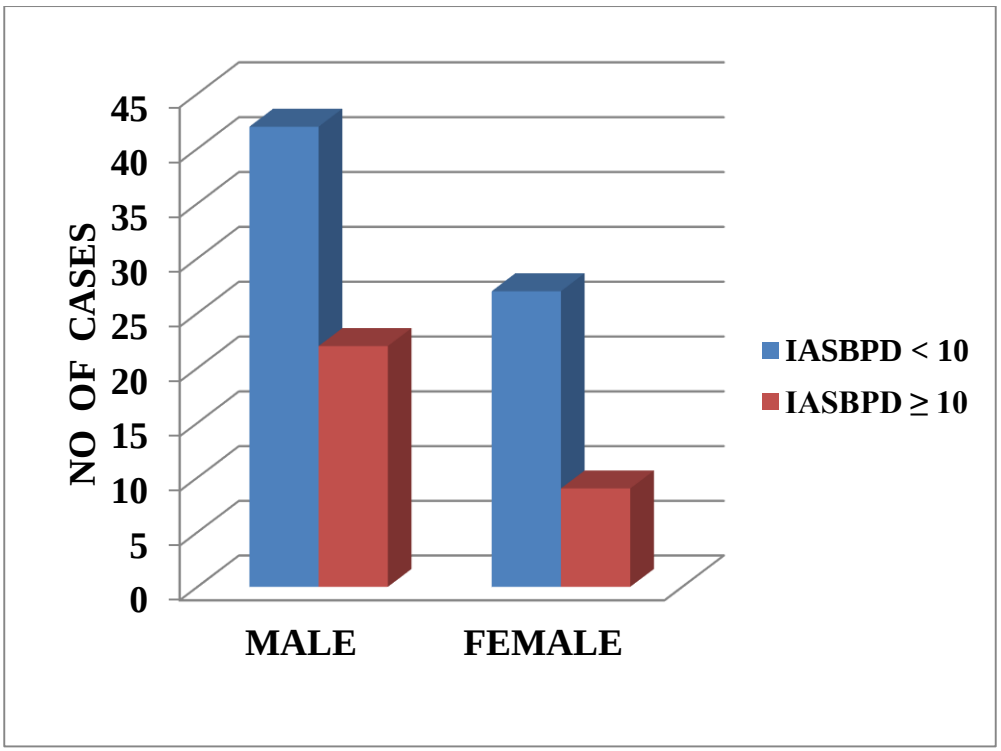


9. CORRELATION OF CIMT WITH AGE, BMI AND CHOLESTEROL

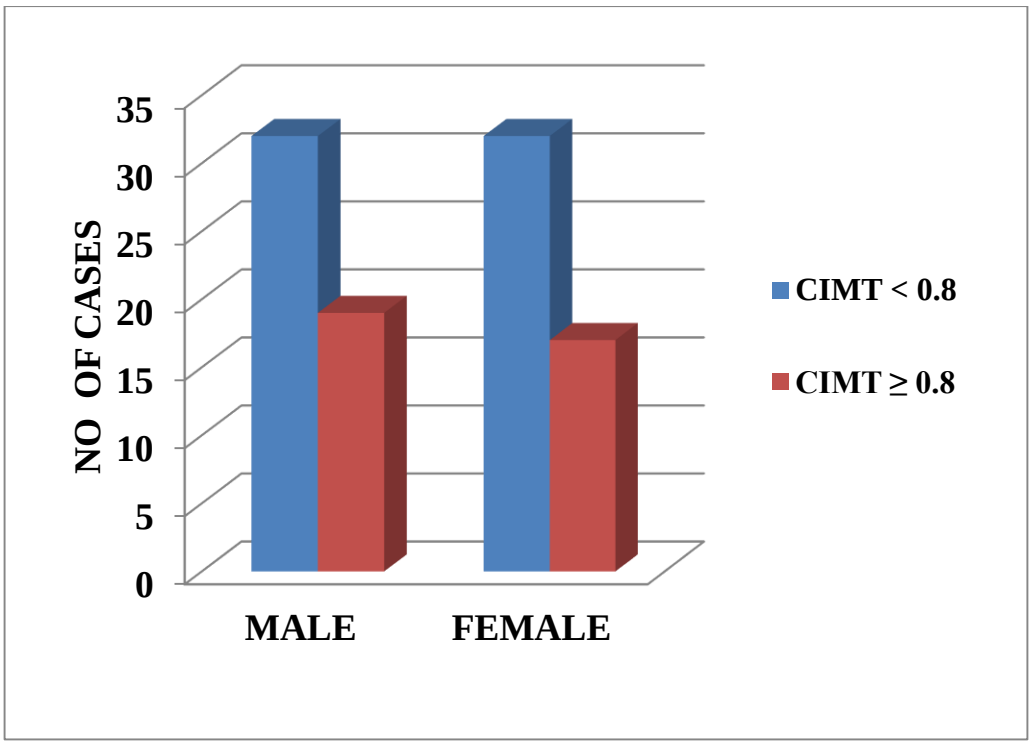
Variable	CIMT in mm	
	r value	**p value**
AGE (years)	0.555	0.00001 **significant**
BMI(kg/m^2)	0.433	0.00001 **significant**
TOTAL CHOLESTEROL (mg/dl)	0.621	0.00001 **significant**

Table – 9 showing correlation of CIMT with age, BMI and total cholesterol of study population. Analysis was done using Pearson's correlation coefficient test. There was a statistically significant positive correlation of CIMT with age, BMI and total cholesterol.

10. ASSOCIATION BETWEEN IASBPD AND SEX



ASSOCIATION BETWEEN CIMT AND SEX



10. ASSOCIATION BETWEEN SEX AND IASBPD AND CIMT

Variable	IASBPD < 10 (mm/Hg)	IASBPD≥10 (mm/Hg)	CIMT< 0.8 (mm)	CIMT≥ 0.8 (mm)
Male	42	22	32	32
Female	27	9	19	17
P Value	0.33 **Insignificant**		0.78 **insignificant**	

Table – 10 showing association of CIMT and IASBPD with sex. Analysis was done using chi-square test. There was no significant association of sex with CIMT and IASBPD.

DISCUSSION

DISCUSSION

Cardiovascular diseases account for approximately one third of all the deaths globally. Ischemic heart disease and stroke are the leading causes for cardiovascular disease burden. Among the risk factors for cardiovascular disease, hypertension increases cardiovascular disease risk by 2-3 fold.

So early diagnosis of hypertension and identification of hypertensive patients at risk of future cardiovascular disease risk will reduce the mortality and morbidity due to cardiovascular diseases. By recording blood pressure difference between arms a simple method, patients at high risk of cardiovascular disease can be identified earlier and further progression of disease can be prevented by appropriate therapeutic measures.

Various studies demonstrated that Interarm systolic BP difference ≥ 10 mm/Hg was a predictor of future cardiovascular events. **Kim et al. 2016** reported significant interarm systolic BP difference (IASBPD) was related to 10 years cardiovascular risk assessed by Framingham risk score. Significant correlation between interarm systolic BP difference and carotid intima media thickness (CIMT) was reported in a study conducted by **Ma et al 2016.**

In view of the above perspective, the present study was conducted to study the correlation between interarm systolic blood pressure difference and carotid intima media thickness in hypertensive patients with coronary artery disease and stroke. In this study, correlation of Interarm systolic blood pressure

difference and carotid intima media thickness with other variables such as age, BMI, and total cholesterol was also evaluated.

A total of 100 hypertensive patients with coronary artery disease (CAD) and stroke were selected for the study. Out of 100, 31 patients had coronary artery disease, 46 had stroke and 26 had both coronary artery disease and stroke.

1. CORRELATION BETWEEN IASBPD AND CIMT

Mean IASBPD in the study population was 7.2 mm/Hg. Out of 100 cases, IASBPD < 10 was present in 69 cases and IASBPD ≥ 10 was present in 31 cases. Mean CIMT in the study population was 0.85mm. Out of 100 cases, CIMT < 0.8mm was present in 51 cases CIMT ≥ 0.8mm was present in 49 cases.

Upper extremity blood pressure differences are usually due to atherosclerosis involving the proximal vasculature supplying the upper extremity, resulting in a reduction in blood pressure in one upper extremity. In patients with subclavian or innominate atherosclerosis, 50% have concomitant coronary artery disease, 27% lower extremity artery involvement and 29% carotid obstructive disease. Patients with carotid artery disease often have multilevel atherosclerotic pathology including the origins of the sub-clavian arteries.

Thereby systolic blood pressure difference in upper extremity is often related to anatomical correlation between atheromatous disease in the carotid, subclavian or the innominate artery.

Arterial stiffness is associated with hypertrophy and atherosclerosis within the capacitance arteries that results in an increase in pulse wave velocity and consequent alterations in the pressure waveform. Alterations in wave reflections combined with increased stiffness may contribute to augmentation of systolic BP. This in turn results in more pronounced interarm systolic BP difference.

There was a statistically significant positive correlation between IASBPD and CIMT ($P < 0.05$) in this study. **V.Aboyans et al, 2010**., demonstrated an independent positive association between interarm systolic BP difference and carotid IMT in the United States cohort assessment(Multi- Ethnic Study of Atherosclerosis, MESA). They suggested that an interarm systolic BP difference $\geq$ 15 mm Hg was associated with elevated carotid IMT values.

MA et Al, 2016 documented that mean values of carotid IMT were increased to a greater level in the high IASBPD group. He concluded in his study that increased IASBPD was related to subclinical atherosclerosis and explained IASBPD can predict cardiovascular disease. The present study results were in accordance with above study results.

H.-J. Hwang et al.2017, demonstrated that increased interarm systolic BP difference was associated with existent carotid plaque, but not to carotid IMT. He concluded in his study that adverse outcomes in patients with increased IASBPD might be linked to atherosclerosis.

2. AGE:

Persons with age group 45 – 70 years were included in this study. Mean age of this study group was 56.16 years.

Correlation of IASBPD with age

In this study, there was a statistically significant positive correlation between interarm systolic BP difference and age ($p < 0.05$)

Kimura et al, 2004 reported absolute IASBPD was significantly and positively correlated with age. **MA et Al, 2016** documented age was significantly associated with IASBPD increasing. The present study was concordant with the above studies. **Grossman et al, 2014** reported age was not associated with IASBPD.

Correlation of CIMT with age

The present study showed statistically significant positive correlation between CIMT and age ($p< 0.05$) and mean CIMT values were high in the age group of 55-65 years. **Paul et al 2012** reported high mean CIMT values in the age group of 61-80 years.

Manuel A. Gómez-Marcos et al 2012 and Paul et al 2012 documented a significant positive correlation of CIMT with age. **Abiodun et al.2018,** reported there was a significant gradual increase in average CIMT with age in the study participants **(r=0.827).**

3. BODY MASS INDEX:

Mean BMI of the study group was 24.61 kg/m^2.

Correlation of IASBPD with BMI

In this study there was a statistically significant positive correlation ($p < 0.05$) of IASBPD with BMI.

Tokitsu et al, 2015 reported that BMI was significantly higher in those with high IASBPD. **Manuel A. Gómez-Marcos et al 2012** showed that IASBPD was significantly correlated with BMI which was in accordance to the present study. **Grossman et al, 2014** reported that BMI was not associated with IASBPD.

Correlation of CIMT with BMI

In this study, statistically significant positive correlation was observed between CIMT and BMI.

The study results were concordant with the study conducted by **Sameeah A.Rashid et al 2015**, who showed a significant positive correlation between CIMT and BMI and more rapid change in IMT occured in the group with BMI values >30 kg/m2.

Abiodun et al. 2018 reported that BMI showed a strong positive correlation with average CIMT($r=0.503, p< 0.05$).

Umeh et al, 2014 reported a weak positive correlation between BMI and CIMT on both sides in their study subjects, which was not statistically significant (r 5.252; P 5.070). **Ibinaiye et al, 2015** found that BMI had a negative correlation with CIMT (r 5–.23; P 5.020).

4. SEX:

Among study population of 100, 64 cases were males and 36 were females. 22 males and 9 females had IASBPD ≥ 10. Mean IASBPD in females was 16.11mm Hg and in males it was12.77mm Hg.

Association of sex with IASBPD

In this study there was no association between sex and IASBPD (p=0.33). **Lane D et al 2002 and Kimura A et al' 2004** have documented gender was not a significant factor associated with a large interarm SBP difference. The present study results were consistent with the above study results.

Ho-Ming Su et al,2012 documented female gender was an independent risk factor for an interarm SBP difference of 10 mmHg or more. **Tokitsuet al,2015** reported male sex was independently and significantly associated with the presence of IASBPD.

Association of sex with CIMT

In this study there was no significant association between sex and CIMT (p value-0.789). 32 males and 17 females had CIMT ≥ 0.8. Mean CIMT in males was 0.88mm and in females was 0.84mm

Ibinaiye et al, 2015 and Relwani PR et al 2017 documented gender difference in CIMT was not statistically significant. The present study showed similar results with above studies.

Paul et al.: 2012, documented sex was significantly correlated with CIMT (p=0.001) and male sex had higher CIMT values than age matched female sex.

5. TOTAL CHOLESTEROL

In this study, mean total cholesterol was 186 mg/dl in the study group. About 23 patients had cholesterol values more than 200 mg/dl.

Correlation of IASBPD with Total cholesterol

In this study correlation between Interarm systolic BP difference and total cholesterol was positive and statistically significant ($p < 0.05$).

Kimura et al, 2004 documented that absolute SBP difference was significantly and positively correlated with total cholesterol. **Weinberg et al, 2013** reported that patients with elevated interarm systolic BP difference had higher total cholesterol (212mg/dl).

Correlation of CIMT with Total cholesterol

In this study there was a significant positive correlation between CIMT and total cholesterol ($p < 0.5$). **V. Mohan et al.1999** reported serum cholesterol level had a positive correlation with cIMT. **Weingartner et al 2010** showed that CIMT was positively correlated with cholesterol ($r = 0.24$, $P < 0.0005$)

Sameeah A. Rashid et al 2015 reported that high serum cholesterol showed significant correlation with CIMT. The present study results were consistent with above study results.

CONCLUSION

CONCLUSION

Present study showed that there was a statistically significant positive correlation between interarm systolic blood pressure difference and carotid intima media thickness in hypertensive patients with coronary artery disease and stroke. Carotid intima media thickness was an important risk marker for atherosclerosis. From above finding it was clear that increased interarm systolic BP difference was related to progression of atherosclerotic process and thereby led to future cardiovascular diseases. So early detection of IASBPD may be useful for preventing the progression of atherosclerosis and reducing cardiovascular mortality.

The vast majority of patients with hypertension are managed in primary care and measurement of BP is the most common investigation performed in this setting. Failure to recognise a difference can lead to underestimation or under-treatment of blood pressure.

By recording blood pressure in both the arms during the first visit not only avoids under diagnosis of hypertension but also helps to stratify hypertensive patients at risk of future cardiovascular diseases. Identification of atherosclerosis in the arteries requires sophisticated imaging techniques and is not routinely assessed in primary care and also requires time, equipment, and expertise. The IASBPD is a simple, economical and effective tool that can be used to screen patients for cardiovascular diseases at the primary health care system itself.

Detection of an interarm BP difference results in prompt consideration of further vascular assessment and aggressive management along secondary prevention guidelines and there by helps to prevent adverse outcomes.

As recording of inter-arm systolic BP difference is a simple, reproducible, and inexpensive method it can be recommended in all clinical settings for stratifying the hypertensive patients at risk of future cardiovascular disease.

LIMITATIONS

- As the study was conducted in a small population, further studies with large sample size need to be done to strengthen the results.
- In this study only carotid atherosclerosis was assessed by carotid Doppler. Further studies with investigations directed to assess the severity of coronary and cerebral atherosclerosis such as coronary and MR angiography need to be done.
- Further prospective studies are needed to assess the prognostic value of IASBPD in patients with cardiovascular diseases.

BIBLIOGRAPHY

BIBLIOGRAPHY

1. Aboyans V, Kamineni A, Allison MA, McDermott MM, Crouse JR, Ni H, et al. The epidemiology of subclavian stenosis and its association with markers of subclinical atherosclerosis: the MultiEthnic Study of Atherosclerosis (MESA). Atherosclerosis 2010; 211:266–270.
2. Aboyans V (2013) Asymmetrical limbs arterial pressures: a new marker of atherosclerosis. Hypertens Res 36(5):394–395
3. ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA 2017 guidelines for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults .Paul K. Whelton, Robert M. Carey, Wilbert S. Aronow, Donald E. Casey,Karen J. Collins, Cheryl Dennison Himmelfarb, Sondra M. DePalma,Samuel Gidding, Kenneth A. Jamerson, Daniel W. Jones, Eric J. MacLaughlin, Paul Muntner, Bruce Ovbiagele, Sidney C. Smith, Crystal C. Spencer, Randall S. Stafford, Sandra J. Taler, Randal J. Thomas, Kim A. Williams, Jeff D. Williamson, Jackson T. Wright Journal of the American College of Cardiology May 2018, 71 (19) e127-e248; DOI: 10.1016/j.jacc.2017.11.006.
4. Amsterdam B, Amsterdam AL. Disparity in blood pressures in both arms in normals and hypertensives and its clinical significance. N Y State J Med1943; 43:2294–2300.
5. Bots ML, Evans GW, Tegeler CH, Meijer R. Carotid Intima‐media Thickness Measurements: Relations with Atherosclerosis, Risk of

Cardiovascular Disease and Application in Randomized Controlled Trials. Chin Med J 2016;129:215‑26

6. Bots ML, Hoes AW, Koudstaal PJ, Hofman A, Grobbee DE. Common carotid intima- media thickness and risk of stroke and myocardial infarction: the Rotterdam Study. Circulation. 1997; 96:1432-7.
7. Burke GL, Evans GW, Riley WA, Sharrett AR, Howard G, Barnes RW, et al. Arterial wall thickness is associated with prevalent cardiovascular disease in middle- aged adults. The Atherosclerosis Risk in Communities (ARIC) Study. Stroke. 1995;26:386–916.
8. Canepa M, Milaneschi Y, Ameri P, et al. Relationship between inter-arm difference in systolic blood pressure and arterial stiffness in community dwelling older adults. J Clin Hypertens (Greenwich)2013; 15(12):880–887
9. Cao K, Xu J, Shangguan Q, et al. Association of an inter-arm systolic blood pressure difference with all-cause and cardiovascular mortality: an updated meta-analysis of cohort studies. Int J Cardiol2015; 189:211–219.
10. Cassidy P, Jones K. A study of inter-arm blood pressure differences in primary care. J Hum Hypertens2001; 15(8):519–522.
11. Chobanian AV, Bakris GL, Black HR, Cushman WC,Green LA, Izzo Jr JL et al. Seventh report of the joint national committee on prevention, detection, evaluation, and treatment of high blood pressure. Hypertension2003;42: 1206–1252
12. Clark CE. Difference in blood pressure between arms might reflect peripheral vascular disease.BMJ2001; 323:399–400.

13. Clark CE, Campbell JL, Evans PH, Millward A. Prevalence and clinical implications of the inter-arm blood pressure difference: a systematic review. J Hum Hypertens2006;20: 923–931.
14. Clark CE, Campbell JL, Powell RJ. The interarm blood pressure difference as predictor of cardiovascular events in patients with hypertension in primary care: cohort study.JHumHypertens2007;21:633–638
15. Clark CE, Taylor RS, Shore AC, Campbell JL. The difference in blood pressure Readings between arms and survival: primary care cohort study.BMJ2012; 344:e1327
16. Clark CE, Taylor RS, Shore AC, Ukoumunne OC, Campbell JL. Association of a difference in systolic blood pressure between arms with vascular disease and mortality: a systematic review and meta-analysis.Lancet2012; 379:905–914.
17. Den Ruijter H.M., Peters S.A.E., Anderson T.J., et al (2012) Common carotid intima-media thickness measurements in cardiovascular risk prediction: a meta- analysis. JAMA 308:796–803.
18. Den Ruijter HM, Peters SA, Anderson TJ, Britton AR, Dekker JM, Eijkemans MJ, Engstrom G, Evans GW, de Graaf J, Grobbee DE, Hedblad B, Hofman A, Holewijn S, Ikeda A, Kavousi M, Kitagawa K, Kitamura A, Koffijberg H, Lonn EM, Lorenz MW, Mathiesen EB, Nijpels G, Okazaki S, O'Leary DH, Polak JF, Price JF,Robertson C, Rembold 15Nepalese Heart Journal 2018; 15(1): 9-15CM, Rosvall M,Rundek T, Salonen JT, Sitzer M, Stehouwer CD, Witteman JC, Moons KG, Bots ML Common

carotid intima- media thickness measurements in cardiovascular risk prediction: a meta- analysis. JAMA 2012; 308:796–803.

19. Gaynor E, Brewer L, Mellon L, Hall P, Horgan N, Shelley E, Dolan E, HickeyA, Bennett K, Williams D, Inter-arm blood pressure difference in a post stroke population, Journal of the American Society of Hypertension (2017), doi: 10.1016/j.jash.2017.06.008.
20. Gomez-Marcos MA, Recio-Rodríguez JI, Patino-Alonso MC, Agudo-Conde C,Gomez-Sanchez L,Gomez-Sanchez M, et al. Protocol for Measuring Carotid Intima-Media Thickness That Best Correlates With Cardiovascular Risk andTarget Organ Damage. Am J Hypertens. 2012 Jun 21.
21. Harrison EG, Roth GM, Hines EA. Bilateral indirect and direct arterial pressures.Circulation1960; 22:419–436
22. H.-J. Hwang, et al., Increased interarm blood pressure difference is associated with autonomic dysfunction and atherosclerosis in patients with chest pain and no history of coronary, Cardiol(2017), Int J.
23. Ibinaiye PO, Kolade-Yinusa HO, Abdukadir A, Yinusa T. Relationship of carotid artery intima media thickness to blood pressure, age and body mass index of hypertensive adult patients. Arch Int Surg2015; 5: 63–68.
24. Kablak-Ziembicka A, Tracz W, Przewlocki T, Pieniazek P, Sokolowski A, Konieczynska M. Association of increased carotid intima-media thickness with the extent of coronary artery disease. Heart 2004; 90(11):1286-1290.

25. Kasliwal RR, Bansal M, Desai D, Sharma M. Carotid intima-media thickness: Current evidence, practices, and Indian experience. Indian J Endocrinol Metab. 2014; 18:13–22.
26. Kay WE, Gardner KD. Comparative blood pressures in the two arms. Cal West Med1930; 33: 578–579.
27. Kim J, Song TJ, Song D, et al. Interarm blood pressure difference and mortality in patients with acute ischemic stroke. Neurology2013; 80(16):1457–1464
28. Kimura A, Hashimoto J, Watabe D, Takahashi H, Ohkubo T, Kikuya M, Imai Y. Patient characteristics and factors associated with inter-arm difference of blood pressure measurements in a general population in Ohasama, Japan. JHypertens2004; 22:2277–2283
29. Kim SA, Kim JY, park JB. Significant interarm blood pressure difference predicts cardiovascular risk in hypertentive patients: CoCoNet study. Medicine.
30. Korns HM, Guinand PH. Inequality of blood pressure in the brachial arteries, with special reference to disease of the arch of the aorta. J Clin Invest1933; 12(1):143–154.
31. Lane D, Beevers M, Barnes N, et al. Inter-arm differences in blood pressure: when are they clinically significant? J Hypertens2002; 20(6):1089–1095.

32. Lorenz MW, Markus HS, Bots ML, Rosvall M, Sitzer M. Prediction of clinical cardiovascular events with carotid intima-media thickness: a systematic review and metaanalysis. Circ2007;115:459467.
33. Ma W, Zhang B, Yang Y, et al. Correlating the relationship between interarm systolic blood pressure and cardiovascular disease risk factors. J Clin Hypertens. 2017; 19:466–471.
34. Maeda S, Okumura Y, Hara N. Association between systolic blood pressure difference ≥10 mmHg and Ankle-Brachial Index. Int J Clin Med 2016; 7:361-9.
35. Magnussen CG. Carotid artery intima-media thickness and hypertensive heart disease: a short review. Clin **Hypertens**. 2017; 23:7.
36. M.J. Roman, T.Z. Naqvi, J.M. Gardin, M. Gerhard-Herman, M. Jaff, E. Mohler Clinical application of noninvasive vascular ultrasound in cardiovascular risk stratification: a report from the American Society of Echocardiography and the Society of Vascular Medicine and Biology J Am Soc Echocardiogr, 19 (2006), pp. 943-954
37. Murari Prasad Barakoti. Carotid intima-media thickness and coronary artery Disease. Nepalese Heart Journal 2018; 15(1): 9-15.
38. Nambi V, Chambless L, He M, Folsom AR, Mosley T, Boerwinkle E, Ballantyne CM. Common carotid artery intima-media thickness is as good as carotid intima-media thickness of all carotid artery segments in improving prediction of coronary heart disease risk in the Atherosclerosis Risk in Communities (ARIC) study. **Eur Heart J**. 2012;33:183–190.

39. Naqvi TZ and Lee MS, Carotid intima-media thickness and plaque in cardiovascular risk assessment. JACC Cardiovasc Imaging. 2014; 7: 1025–1038. pmid:25051948.
40. O'LearyDH, Polak J, Kronmal RA, Manolio TA, Burke GL, Wolfson SKJ Carotid- artery intima and media thickness as a risk factor for myocardial infarction and stroke in older adults. Cardiovascular Health Study Collaborative Research Group, N Engl J Med, 1999, vol. 340 (pg. 14-22) OS.
41. Paul J, Shaw K, Dasgupta S, et al. Measurement of intima media thickness of carotid artery by B- mode ultrasound in healthy people of India and Bangladesh, and relation of age and sex with carotid artery intima media thickness: An observational study. J Cardiovasc Dis Res 2012;3:128-31.
42. P. J. Touboul, E. Vicaut, J. Labreuche et al., "Common carotid artery intima-media thickness: the cardiovascular risk factor multiple evaluation in Latin America (CARMELA) study results," Cerebrovascular Diseases, vol. 31, no. 1, pp. 43–50,2010
43. Rashid SA, Mahmud SA. Correlation between carotid artery intima-media thickness and luminal diameter with body mass index and other cardiovascular risk factors in adults. Sultan Qaboos Univ Med J. 2015;15(3):e344–50. 10.18295/squmj.2015.15.03.007.
44. Raso FM, van Popele NM, Schalekamp MA, van der Cammen TJ**:** Intima-media thickness of the common carotid arteries is related to coronary

atherosclerosis and left ventricular hypertrophy in older adults**.** Angiology 2002, 53:569–574.

45. Robertson CM, Fowkes FG, Price JF. Carotid intima-media thickness and the prediction of vascular events. Vasc Med. 2012 Jun 13.
46. Simova I. Intima media thickness: appropriate evaluation and proper measurement, described. An article from the e-journal of the ESC Council for Cardiology Practice. European Society of Cardiology 2015:13
47. Stein, J. H., and H. M. Johnson. 2010. Carotid intima-media thickness, plaques, and cardiovascular disease risk: implications for preventive cardiology guidelines. J. Am. Coll. Cardio55:1608–161.
48. Su HM, Lin TH, Hsu PC, et al. Association of interarm systolic blood pressure difference with atherosclerosis and left ventricular hypertrophy. PLoS One 2012; 7(8):e41173. Doi:10.1371/journal.pone.0041173
49. Touboul PJ, Hennerici MG, Meairs S et al. Mannheim carotid intima-media thickness consensus (2004 to 2006). Cerebrovascular Diseases 2006;23(1):75
50. Verberk WJ, Kessels AG, Thien T. Blood pressure measurement method and inter-arm differences: a meta-analysis.Am J Hypertens 2011; 24:1201–1208.
51. Weinberg I, Gona P, O'Donnell CJ, et al. The systolic blood pressure difference between arms and cardiovascular disease in the Framingham heart study. Am J Med2014; 127(3):209–21510

52. Weingartner O, Pinsdorf T, Rogacev KS, Blomer L, Grenner Y, Graber S, Ulrich C, Girndt M, Fliser D, Laufs U, Lutjohann D, Heine GH. The relationships of markers of cholesterol homeostasis with carotid intima-media thickness. PLOS ONE**.** 2010; 5:e13467.

CORRELATION BETWEEN INTERARM SYSTOLIC BLOOD PRESSURE DIFFERENCE AND CAROTID INTIMA MEDIA THICKNESS IN PATIENTS WITH CORONARY ARTERY DISEASE AND STROKE

PROFORMA

Name: Age in years: Sex: M/F

Occupation: OP/ IP no:

Address:

H/O PRESENTING COMPLAINTS:

H/O chest pain – YES/NO

site, any radiation, aggravated by exertion

H/O shortness of breath on exertion YES/NO

H/O palpitation YES/NO

H/O puffiness of face YES/NO

H/O edema of legs YES/NO

H/O giddiness/loss of consciousness YES/NO

H/O weakness in arms or legs YES/NO

H/O difficulty in swallowing YES/NO

H/O speech disturbance YES/NO

H/O transient loss of vision YES/NO

H/O drooling of saliva YES/NO

H/O deviation of angle of mouth YES/NO

H/O nasal bleed YES/NO

H/O decreased urine output YES/NO

H/O pain in the legs while walking YES/NO

PAST HISTORY:

H/O similar episodes before	YES/NO
H/O Hypertension,	YES/NO
H/O DiabetesMellitus/Chronickidneydisease	YES/NO
H/O Ischemic Heart Disease	YES/NO
H/O Transient Ischemic Attack	YES/NO
H/O Stroke	YES/NO
H/O peripheral vascular disease	YES/NO

PERSONAL HISTORY:

Dietary habits	VEG/NONVEG
H/O smoking	YES/NO
H/O alcohol intake	YES/NO

FAMILY HISTORY:

H/O Hypertension/ Diabetes mellitus	YES/NO
Coronary artery disease/ Stroke/ Kidney disease	

GENERAL EXAMINATION:

Consciousness		Orientation	Pallor
Cyanosis		Icterus	Clubbing
Pedal edema			
Pulse rate :	/minute	Rhythm;	Volume
Respiratory rate:	/minute	Temperature:	^{0}F

Recording of Interarm systolic blood pressure difference

Blood pressure in mm/Hg :	Right arm	Left arm
1.		
2.		
3.		
Average:		

Absolute Inter arm BP difference:	Systolic BP (|Right-Left|)	Diastolic BP (|Right-Left|)

ANTHROPOMETRIC MEASUREMENTS:

Height (cm): Weight (kg): BMI (kg/m^2):

SYSTEMIC EXAMINATION:

Cardiovascular system:

Respiratory system:

Abdomen:

Central nervous system:

INVESTIGATIONS:

Carotid Doppler ultrasound

Fasting & Postprandial Blood sugar

Blood urea:

Serum creatinine:

Lipid profile:

ECG

மருத்துவ பரிசோதனைமுறைகளைப் பற்றி மருத்துவரிடம் தெரிந்து கொண்டேன். இதனை மேற்கொள்ள நான் முழுமனதுடன் சம்மதிக்கிறேன்.

MASTER CHART FOR STUDY POPULATION

Sl.no.	Name	Age (yrs)	Sex	Ht (cms)	Wt (kg)	BMI (kg/m^2)	PR /min	RR /min	BP (mmHg)	IASBPD (mmHg)	CIMT (mm)	Total cholesterol (mg/dl)
1.	Krishnan	58	M	167	69	24.9	84	20	120/76	1	0.72	167
2	Kamatchi	61	F	165	74	27.4	76	18	154/91	5	0.8	182
3	Chinnasamy	54	M	169	86	30.3	82	22	116/83	4	0.76	202
4	Ramayee	55	F	163	65	24.7	78	18	148/86	10	0.99	196
5	Sekaran	57	M	167	74	26.8	80	18	146/87	13	1.32	226
6	Murugan	61	M	169	66	23.2	74	22	112/78	3	0.82	195
7	Palanisamy	45	M	171	74	25.6	82	18	123/86	8	0.67	164
8	Sarasu	57	F	154	58	24.7	72	20	120/78	5	0.87	173
9	Sivakumar	63	M	163	69	26.1	82	20	136/78	11	0.99	196
10	Palani	68	M	174	68	22.5	68	20	109/73	6	0.93	157
11	Pappathy	58	F	162	74	28.4	92	22	118/72	4	0.71	182
12	Jakir Hussain	59	M	173	78	26.1	98	20	98/79	5	0.66	178
13	Petchikalai	55	M	164	65	24.4	78	18	120/76	4	0.81	188
14	Vasantha	49	F	164	67	25.1	82	20	144/85	8	0.69	201
15	Perumal	52	M	167	58	20.8	88	22	102/84	5	0.87	175
16	Kandasamy	61	M	159	64	25.6	76	20	138/89	13	1.1	182
17	Pandiarajan	58	M	165	78	29	84	18	142/86	12	1.01	204
18	Lakshmi	67	F	157	63	25.6	78	20	110/70	9	0.75	184
19	Karuppanan	56	M	166	77	28.2	92	20	98/64	7	0.65	195
20	Chinnapandi	65	M	177	76	24.3	88	22	128/83	11	1.12	211

Sl.no.	Name	Age (yrs)	Sex	Ht (cms)	Wt (kg)	BMI (kg/m^2)	PR /min	RR /min	BP (mmHg)	IASBPD (mmHg)	CIMT (mm)	Total cholesterol (mg/dl)
21	Aanandi	52	F	161	59	22.8	74	18	120/70	5	0.86	169
22	Shanmugam	58	M	156	59	24.5	82	20	136/81	10	0.97	196
23	Saraswathi	68	F	154	58	24.5	78	22	130/70	6	0.73	172
24	Gajalakshmi	58	F	161	55	21.6	82	18	122/78	3	0.7	183
25	Vijaya	52	F	158	56	22.4	98	22	90/60	1	0.67	188
26	Chinnaya	65	M	166	65	23.8	84	18	142/87	12	1.12	182
27	Devi	54	F	169	86	30.2	88	20	113/72	9	0.84	211
28	Thavapandi	59	M	167	73	26.4	78	18	128/85	16	1.4	209
29	Sathyamoorthy	66	M	168	68	24.3	84	20	126/70	8	0.88	185
30	Meyyammai	52	F	169	55	19.5	92	20	110/81	8	0.67	172
31	Jeyachandran	57	M	175	64	20.9	81	20	108/74	4	0.78	176
32	Kaliammal	67	F	156	62	25.7	92	20	116/85	7	0.9	182
33	Muruganantham	62	M	168	74	26.3	84	18	151/73	14	1.19	204
34	Kannan	51	M	167	61	21.9	96	22	120/81	6	0.66	187
35	Nagoorammal	55	F	160	61	24.2	82	18	128/77	11	1.04	181
36	Sadayandi	52	M	168	60	21.3	78	22	106/71	2	0.62	172
37	Sundari	56	F	159	66	26.1	82	20	121/75	4	0.72	188
38	Aandavar	56	M	171	69	23.9	86	18	111/74	11	0.98	202
39	Selvaraj	51	M	162	58	22.1	92	20	98/71	2	0.61	192
40	vellaiammal	66	F	169	76	26.7	84	20	141/92	17	1.31	218

Sl.no.	Name	Age (yrs)	Sex	Ht (cms)	Wt (kg)	BMI (kg/m^2)	PR /min	RR /min	BP (mmHg)	IASBPD (mmHg)	CIMT (mm)	Total cholesterol (mg/dl)
41	Panchu	48	F	154	46	19.4	74	18	112/73	3	0.69	168
42	Murugeswari	53	F	156	57	23.5	81	20	110/80	3	0.62	177
43	Marimuthu	48	M	172	79	23.7	85	22	134/72	10	0.76	191
44	Soundarapandian	55	M	168	62	28.2	74	18	121/82	5	0.81	203
45	Veerasamy	52	M	159	55	21.8	96	20	97/72	4	0.69	183
46	RaniS	59	F	162	64	24.6	84	22	127/78	13	1.06	187
47	Balu	53	M	158	56	22.6	92	20	111/78	3	0.71	179
48	Rakkammal	46	F	165	59	21.8	76	18	102/68	4	0.72	182
49	Muniyandi	65	M	168	74	26.4	82	20	151/94	16	1.28	216
50	Kannan	47	M	170	62	21.5	88	20	123/81	8	0.62	187
51	Subbulakshmi	56	F	162	58	22.1	82	20	131/80	7	0.78	173
52	Thavamani	64	M	175	67	22.2	70	18	114/77	4	0.64	158
53	Manikandan	48	M	177	77	24.7	88	20	138/76	12	1.04	185
54	Gokila	52	F	159	50	19.8	76	22	106/78	1	0.71	161
55	Pethammal	53	F	152	56	24.2	81	20	141/84	3	0.66	171
56	Gomathinayagam	65	M	165	76	28	78	22	129/86	18	1.41	218
57	Pandi	53	M	174	64	21.1	90	18	114/88	2	0.6	184
58	Parimalar	59	F	167	71	25.5	82	20	152/95	16	1.18	218
59	Rasu	47	M	164	62	23.3	81	20	139/88	5	0.76	212
60	Peter joseph	50	M	176	65	21	77	18	123/81	1	0.64	182

Sl.no.	Name	Age (yrs)	Sex	Ht (cms)	Wt (kg)	BMI (kg/m^2)	PR /min	RR /min	BP (mmHg)	IASBPD (mmHg)	CIMT (mm)	Total cholesterol (mg/dl)
61	Balamurugan	54	M	167	78	28.1	82	20	148/86	11	0.91	204
62	Rameshwari	48	F	159	60	24	75	22	120/77	3	0.65	166
63	Raghavan	51	M	170	75	26.1	86	20	138/72	8	0.9	221
64	Alagumalai	49	M	167	59	21.2	80	18	144/91	4	0.64	156
65	Nagarani	62	F	157	59	24.2	76	20	146/92	14	1.01	185
66	Malarkodi	57	F	159	60	24.1	74	18	110/72	2	0.71	177
67	Kulanthaisamy	51	M	162	60	23	91	20	121/84	2	0.69	194
68	Thirumurugan	58	M	160	62	24.2	81	18	120/71	4	0.84	172
69	Sadayandi	54	M	168	73	25.9	86	20	129/88	11	0.92	182
70	Kamala	52	F	162	74	28.4	79	22	158/96	6	0.88	164
71	Kilikomban	50	M	158	55	22	92	20	127/82	3	0.62	182
72	Vinayagamoorthy	58	M	172	80	27.2	72	18	105/76	5	0.69	172
73	Bharadan	68	M	161	68	26.4	84	20	155/82	17	1.37	219
74	Angumani	51	F	169	60	21	78	20	141/86	3	0.61	182
75	Syed Ibrahim	58	M	172	69	23.3	89	22	98/65	4	0.73	175
76	Guruvammal	62	F	161	65	25.3	78	20	165/82	12	1.23	191
77	Mohammed Ali	65	M	159	64	25.5	91	20	126/78	3	0.81	177
78	Parthiban	55	M	166	72	26.2	76	18	129/82	14	1.3	209
79	Nagarathinam	54	F	160	65	25.4	78	20	104/66	4	0.66	163
80	Arjunan	49	M	179	71	22.3	82	20	111/82	2	0.73	179

Sl.no.	Name	Age (yrs)	Sex	Ht (cms)	Wt (kg)	BMI (kg/m^2)	PR /min	RR /min	BP (mmHg)	IASBPD (mmHg)	CIMT (mm)	Total cholesterol (mg/dl)
81	Soundarajan	57	M	158	64	25.7	81	20	155/92	12	1.1	182
82	Mariselvi	51	F	171	69	23.9	78	18	113/82	6	0.92	175
83	Kamarajan	49	M	164	67	25.2	84	22	130/71	4	0.66	169
84	Veluthai	64	F	168	87	31	78	20	124/83	19	1.38	214
85	Karuppanan	55	M	163	65	24.7	76	18	116/74	2	0.63	171
86	Mayandi	52	M	168	71	25.4	78	18	126/88	4	0.74	177
87	Tamilselvan	60	M	171	75	25.9	91	20	137/90	7	0.87	192
88	Arumugam	70	M	162	67	25.8	76	18	120/78	9	0.97	187
89	Chandrasekar	48	M	163	59	22.3	88	20	109/66	3	0.61	184
90	Annalakshmi	62	F	156	60	24.7	80	18	138/90	15	1.18	192
91	Arokiasamy	65	M	164	63	23.6	77	20	143/89	12	0.92	201
92	Ayyanar	56	M	162	66	25.3	74	18	114/80	1	0.65	178
93	Veeramani	53	M	172	76	25.7	83	20	136/74	2	0.7	182
94	Kalaiselvi	58	F	156	63	26.2	92	20	123/78	4	0.82	230
95	Maruthamuthu	46	M	159	76	30.1	79	18	109/67	8	0.78	178
96	Thomas	54	M	168	62	22.1	80	20	117/85	5	0.8	183
97	Shanmugavel	63	M	163	67	25.5	78	20	164/98	14	1.03	208
98	Annadurai	51	M	175	74	24.3	82	20	129/81	11	0.79	188
99	Veeralakshmi	52	F	152	56	24.3	69	18	106/73	6	0.63	162
100	Ganesan	55	M	178	87	27.6	82	20	134/85	6	0.76	175

ABBREVIATIONS

Sl.No.	ABBREVIATION	EXPANSION
1.	CVD	Cardiovascular disease
2.	JNC	Joint national committee
3.	CAD	Coronary artery disease
4.	CHD	Coronary heart disease
5.	IASBPD	Interarm systolic bloodpressure difference
6.	CIMT	Carotid intima media thickness
7.	PWV	Pulse wave velocity
8	ABI	Ankle- brachial index
9.	ASE	American Society of Echocardiography
10.	RAAS	Renin-angiotensin-aldosterone system
11.	ISH	Isolated systolic hypertension
12.	CHF	Congestive heart failure
13.	PAD	Peripheral arterial disease
14.	ACCF	American College of Cardiology Foundation
15.	AHA	American Heart Association
16.	CRP	C-reactive protein
17.	ESC	European society of cardiology
18.	LVH	Left ventricular hypertrophy
19.	LVMI	Left ventricular mass index

MADURAI MEDICAL COLLEGE
MADURAI, TAMILNADU, INDIA -625 020
(Affiliated to The Tamilnadu Dr.MGR Medical University, Chennai, Tamil Nadu)

ETHICS COMMITTEE CERTIFICATE

Name of the Candidate	:	Dr.M.Mahalakshmi
Course	:	PG in MD., Physiology
Period of Study	:	2016-2019
College	:	MADURAI MEDICAL COLLEGE
Research Topic	:	Correlation between inter arm systolic blood pressure difference and carotid intima media thickness in patients with coronary artery disease and stroke.
Ethical Committee as on	:	13.04.2018

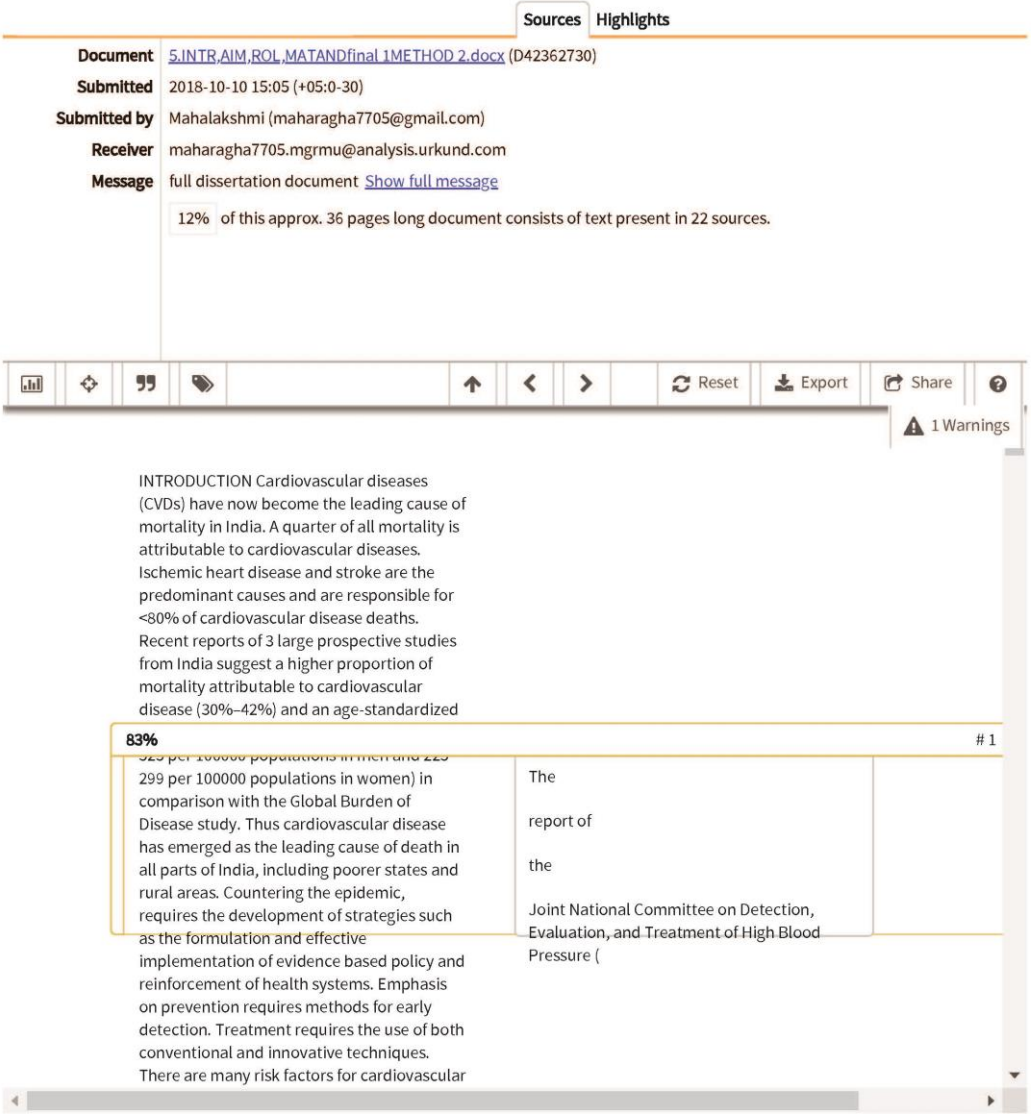
The Ethics Committee, Madurai Medical College has decided to inform that your Research proposal is accepted.

Member Secretary

Chairman
Prof Dr V Nagaraajan
M.D., MNAMS, D.M., Dsc.,(Neuro), Dsc (Hon)
CHAIRMAN
IEC - Madurai Medical College
Madurai

Dean/Convenor
DEAN
Madurai Medical College
Madurai-20

12 JUN 2018


Sources
Highlights
Document 5.INTR,AIM,ROL,MATANDfinal 1METHOD 2.docx (D42362730)
Submitted 2018-10-10 15:05 (+05:0-30)
Submitted by Mahalakshmi (maharagha7705@gmail.com)
Receiver maharagha7705.mgrmu@analysis.urkund.com
Message full dissertation document Show full message
12% of this approx. 36 pages long document consists of text present in 22 sources.
Reset
Export
Share
1 Warnings
INTRODUCTION Cardiovascular diseases (CVDs) have now become the leading cause of mortality in India. A quarter of all mortality is attributable to cardiovascular diseases. Ischemic heart disease and stroke are the predominant causes and are responsible for <80% of cardiovascular disease deaths. Recent reports of 3 large prospective studies from India suggest a higher proportion of mortality attributable to cardiovascular disease (30%–42%) and an age-standardized
83%
1
299 per 100000 populations in women) in comparison with the Global Burden of Disease study. Thus cardiovascular disease has emerged as the leading cause of death in all parts of India, including poorer states and rural areas. Countering the epidemic, requires the development of strategies such as the formulation and effective implementation of evidence based policy and reinforcement of health systems. Emphasis on prevention requires methods for early detection. Treatment requires the use of both conventional and innovative techniques. There are many risk factors for cardiovascular
The
report of
the
Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure (

Gmail

Search mail

Compose

Inbox 133

Starred

Snoozed

Important

Sent

Drafts 11

Categories

Personal

moovendan

No recent chats

Start a new one

[Urkund] 11% similarity - maharagha7705

report@analysis.urkund.com

to me

Document sent by: maharagha7705@gmail.com
Document received: 10/10/2018 11:35:00 AM
Report generated 10/10/2018 11:37:13 AM by Urkund's system for au

Student message:

Document : 5.INTR,AIM,ROL,MATANDfinal 1METHOD 2.docx [D423

IMPORTANT! The analysis contains 1 warning(s).

About 11% of this document consists of text similar to text found in 10

PLEASE NOTE that the above figures do not automatically mean that suspicion of academic dishonesty to present itself, the analysis, poss

CERTIFICATE

This is to certify that this dissertation titled **"CORRELATION BETWEEN INTERARM SYSTOLIC BLOOD PRESSURE DIFFERENCE AND CAROTID INTIMA MEDIA THICKNESS IN PATIENTS WITH CORONARY ARTERY DISEASE AND STROKE"** of the candidate **DR.M.MAHALAKSHMI** for the award of **M.D** degree in the branch of PHYSIOLOGY. I personally verified the urkund.com website for the purpose of plagiarism check. I found that the uploaded thesis file containing from introduction to conclusion pages and result shows **11** percentage of plagiarism in the dissertation.

Dr.P.S.L.Saravanan, M.D.,

The Director (i/c) and Professor,

Institute of Physiology,

Madurai Medical College,

Madurai.